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Aviation Weather Center (AWC) Area Forecaster and Convective SIGMET Forecaster Human Factors Evaluation Report

William Benner
Thomas Carty

September 1997

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16. Abstract

This report describes the human factors evaluation of the Aviation Weather Center (AWC) forecaster work area conducted by ACT-320 at AWC in Kansas City, Missouri, from October 30 through November 3, 1995, and November 14 through November 17, 1995.

The evaluation of the AWC forecaster work area revealed several issues that impacted the performance, comfort, and workload of forecasters. The following problems could create considerable unnecessary task loading on the forecaster during severe weather conditions:

a. Awkward workspace arrangement,
b. Poorly organized menu systems,
c. Lack of a help system/reference information, and
d. The need for excessive control actions.

Given the requirement for timeliness in the forecaster's tasks, care should be taken to resolve any problems that may hinder performance or increase workload. Implementation of recommended solutions as well as an ergonomically designed workspace should provide forecasters with a future work area that shows improvement over the current configuration.

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EXECUTIVE SUMMARY

This report describes the human factors evaluation of the Aviation Weather Center (AWC) forecaster work area conducted by ACT-320 at AWC in Kansas City, Missouri, from October 30 through November 3, 1995, and November 14 through November 17, 1995. Specific results, conclusions, and recommendations for the evaluation are detailed within the report.

Under agreement with the Federal Aviation Administration (FAA), AWC issues Area Forecasts, Airmen Meteorological Statements (AIRMETs), Significant Meteorological Statements (SIGMETs), convective SIGMETs, and International SIGMETs for aviation use. To accomplish these tasks, forecasters must assimilate information from numerous individual systems, each having its own unique user interface. The need to interface with numerous systems raised concerns that forecasters have to work with too many separate workstations, keyboards, mice, and monitors.

In order to make the process of forecasting and the creation and distribution of advisories more efficient, it was necessary to identify human factors problems associated with the current workstations/systems and their setup. Toward that end, the AWC requested the FAA Technical Center (ACT-320) conduct a human factors evaluation of current systems and provide suggestions for planned systems.

The evaluation was conducted in the Experimental Forecast Facility forecaster work area mockup. This mockup emulated operational forecaster work areas. The objectives of the human factors evaluation were to identify aspects of the current software and hardware configuration that impose a negative impact on human performance, workload, and user satisfaction; to determine an optimal physical layout or workstation design for the projected forecaster work space; and to research and recommend possible solutions for mitigating shortcomings in the current and planned designs. The evaluation was conducted in four stages: a preliminary questionnaire, a system review, a task analysis, and a verification stage.

The evaluation of the AWC forecaster work area revealed several issues that impacted the performance, comfort, and workload of forecasters. The following problems could create considerable unnecessary task loading on the forecaster during severe weather conditions:

a. Awkward workspace arrangement,
b. Poorly organized menu systems,
c. Lack of a help system/reference information, and
d. The need for excessive control actions.

Under good weather conditions, some of the forecaster work area problems are easily overcome and are sometimes no more than minor annoyances. However, during severe weather conditions, this increased task loading may result in slowed performance, errors, and unnecessary job stress and discomfort. The impact of these problems are especially evident when a forecaster has been away from the position for a few days or longer.

The conclusions and recommendations contained within this report should be assessed for their feasibility and integrated into the current forecaster's work area if possible. Special consideration should be given to these recommendations when developing specifications for the future work space at the AWC. While these recommendations will not resolve every problem, they will, if implemented, overcome numerous human factors problems within the current forecaster work area.

1. INTRODUCTION.

Under agreement with the Federal Aviation Administration (FAA), the Aviation Weather Center (AWC) located at the National Severe Storms Forecast Center in Kansas City, Missouri, issues Area Forecasts (FAs), Airmen Meteorological Statements (AIRMETs), Significant Meteorological Statements (SIGMETs), Convective SIGMETs, and International SIGMETs for aviation use. To accomplish these tasks, forecasters must assimilate information from various systems and monitors. Under the current configuration at AWC, forecasters must interface with numerous individual systems, each having its own unique user interface. The need to interface with numerous systems raises concerns that forecasters have to work with too many separate workstations, keyboards, mice, and monitors.

AWC is currently upgrading the workstations and tools used to forecast weather and broadcast weather advisories. In order to make the process of forecasting and the creation and distribution of advisories more efficient, it is necessary to identify human factors problems associated with the current workstations/systems and their setup. Toward that end, the AWC requested the FAA Technical Center (ACT-320) conduct a human factors evaluation of current systems and provide suggestions for planned systems. Evaluation procedures addressed the impact on human operators (weather forecasters) of issues such as workspace layout, software usability, and environmental factors (e.g., lighting). The evaluation was conducted in four stages: a preliminary questionnaire, a system review, a task analysis, and a verification stage.

1.1 PURPOSE.

The purpose of this evaluation report is to document results of the AWC human factors evaluation.

1.2 SCOPE.

This report summarizes the AWC Human Factors Evaluation conducted at the AWC. The report is written using FAA-STD-024B as a guideline. Section and paragraph titles were changed where appropriate. The contents of this report include a summary of the current displays/workstations, evaluation descriptions, identification of current problem areas, evaluation results, conclusions, and finally, recommendations for current and future AWC forecaster work areas. This report does not assess the feasibility of incorporating all recommendations or solutions.

2. REFERENCE DOCUMENTS.

FAA-STD-024B	FAA Standard 024B, Content and Format Requirements for the Preparation of Test and Evaluation Documentation, August 22, 1994.
ESD-TR-86-278	Guidelines for Designing User Interface Software, August 1986.
AFOTEC Pamphlet 99-102	Air Force Operational Test and Evaluation Center (AFOTEC) Software Usability Evaluation Guide, Volume 4, June 1994.
MIL-STD-1472D	Military Standard 1472D, Human Engineering Guidelines, March 14, 1989.
DOT/FAA/CT-TN89/53	A Glossary of Terms, Definitions, Acronyms, and Abbreviations Related to the National Airspace System, June 1990.

3. SYSTEM DESCRIPTION.

3.1 MISSION REVIEW.

AWC's operation is divided into three area forecast sections (east, central, and west) and a convective forecast section. One forecaster is assigned to each of the area forecast sections. One convective forecaster is responsible for all convective activity throughout the contiguous states.

AWC forecasters forecast and disseminate weather for aviation use in each section. Products disseminated include FAs, AIRMETs, SIGMETs, convective SIGMETs, and International SIGMETs. These products are utilized by Flight Service Station Specialists, Air Traffic Controllers, Center Weather Service Unit (CWSU) meteorologists, airlines, and pilots.

3.2 SYSTEM CONFIGURATION.

This section presents an overview of displays and systems utilized by forecasters to complete their job tasks. System information collected during the System Review stage was used to create this overview section. This section is intended to familiarize the reader with current AWC systems.

The following displays/systems are located at each of the AWC forecaster sections:

a. Visual Infrared Spin Scan Radiometer (VISSR) Atmospheric Sounder (VAS) Data Utilization Center (VDUC);

b. National Center for Environmental Prediction Advanced Weather Interactive Processor System (N-AWIPS);

c. National Lightning Detection System (NLDS) dedicated display;

d. National Radar display;

e. Personal Computer (PC);

f. Dedicated Satellite display; and

g. Automated Family of Services (AFOS) equipment.

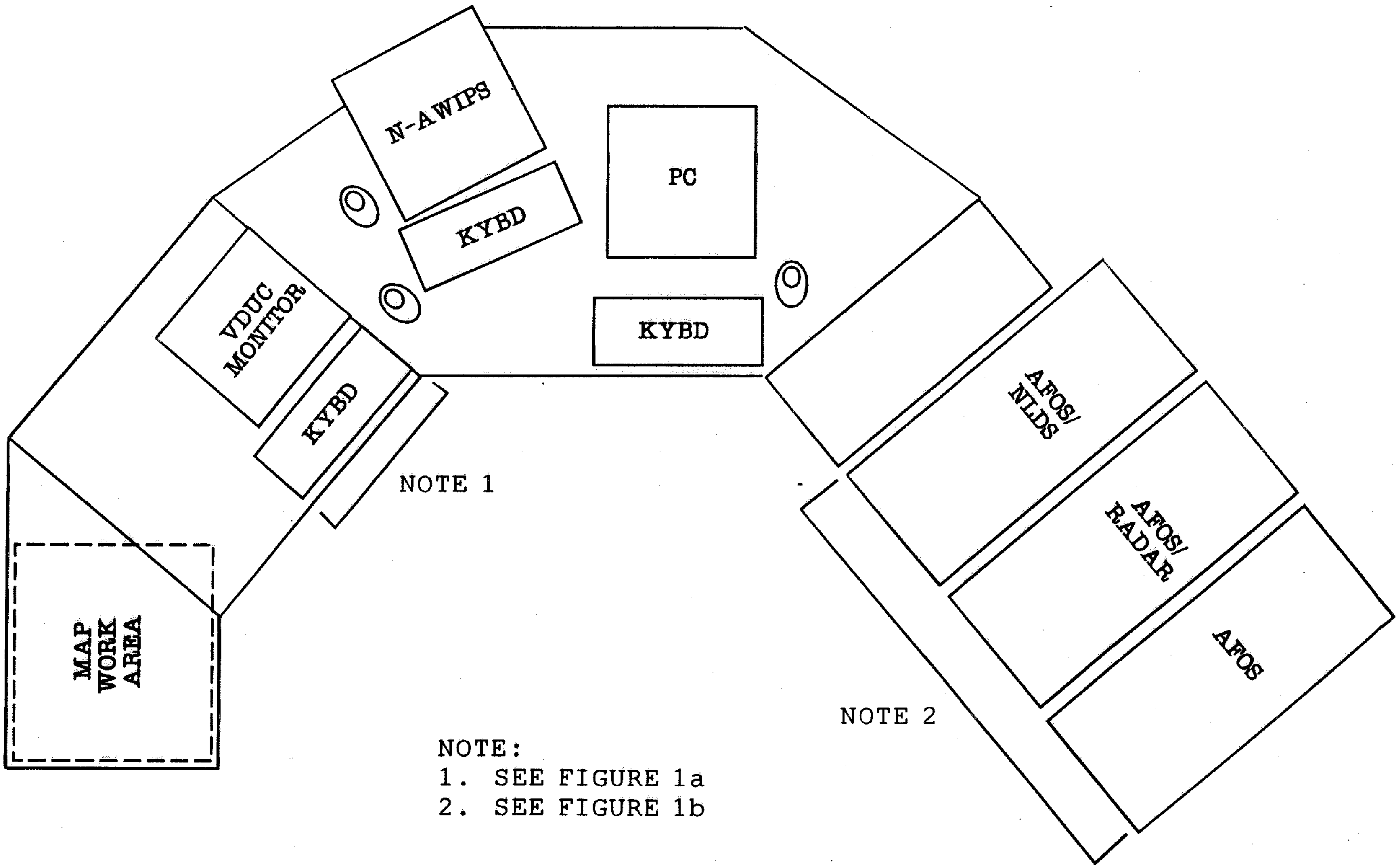
Forecasters utilize these systems and displays to create and disseminate AIRMETs, SIGMETs, and FAs. Figure 1 illustrates the workspace layout for the East Forecast Area. The Central and West Areas are very similar to this layout. Convective forecasters have a Next Generation Radar (NEXRAD) display in their work area. Each of these displays/systems are briefly described in the following paragraphs. Detailed information regarding each of these systems can be found in appendix A.

3.2.1 VDUC.

The VDUC system consists of a graphics monitor, a text monitor, a keyboard, and a mouse. Information can be retrieved in both a graphical and textual format. The VDUC uses both a command line and menu driven interface. While the forecaster can use the VDUC to review numerous types of weather data (e.g., satellite imagery, clouds, weather, and Pilot Reports [PIREPs]), it is typically configured to display satellite imagery with various product overlays.

3.2.2 N-AWIPS.

The N-AWIPS system consists of one or two monitors, a keyboard, and a mouse. N-AWIPS is a UNIX based system on which information can be retrieved in both a graphical and textual format. The N-AWIPS primary interface is menu driven; however, in some packages such as the AFOS emulator, data can be retrieved utilizing typed text commands. Although other information is available, the



NOTE:
1. SEE FIGURE 1a
2. SEE FIGURE 1b

FIGURE 1. EAST FORECASTER AREA

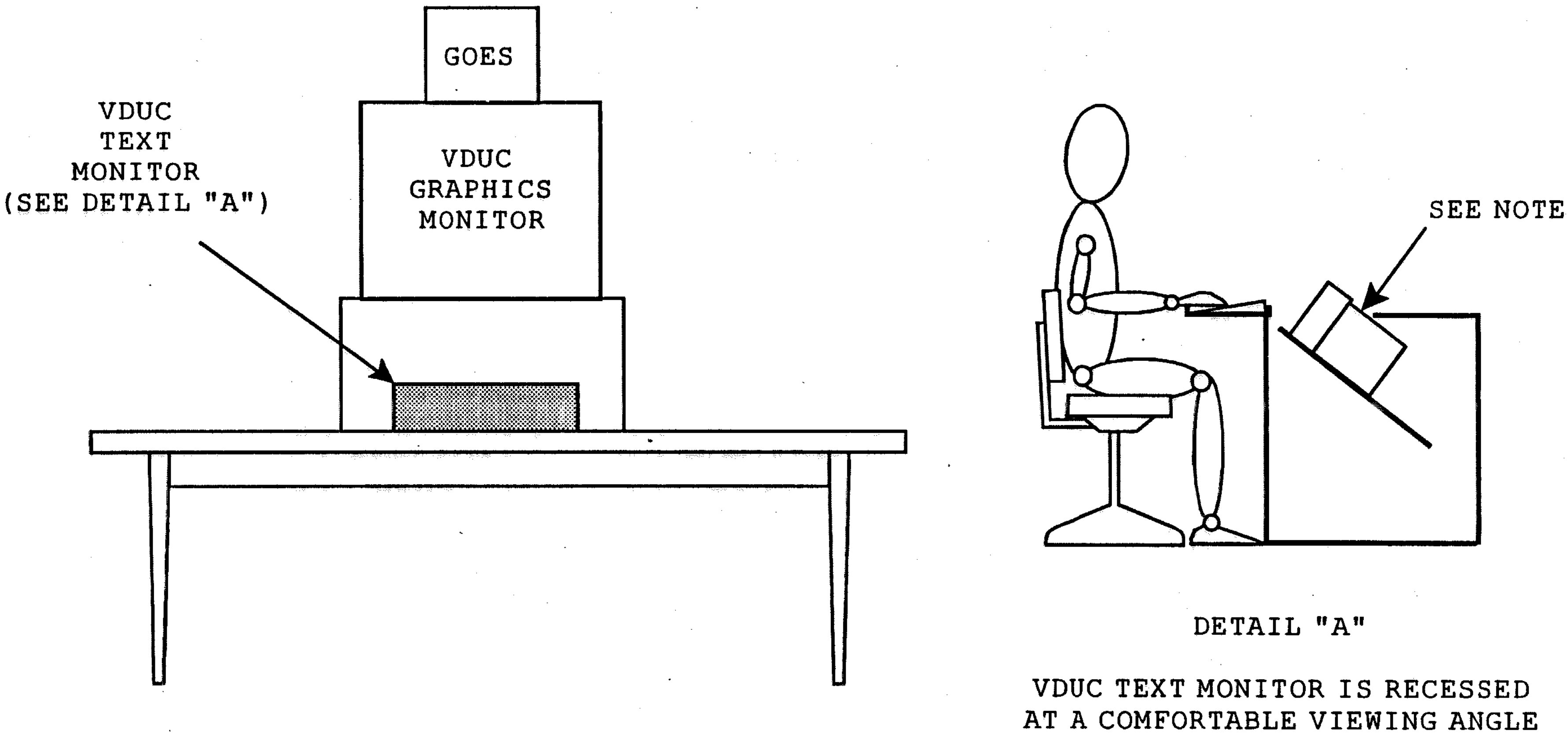


FIGURE 1a. VDUC ARRANGEMENT

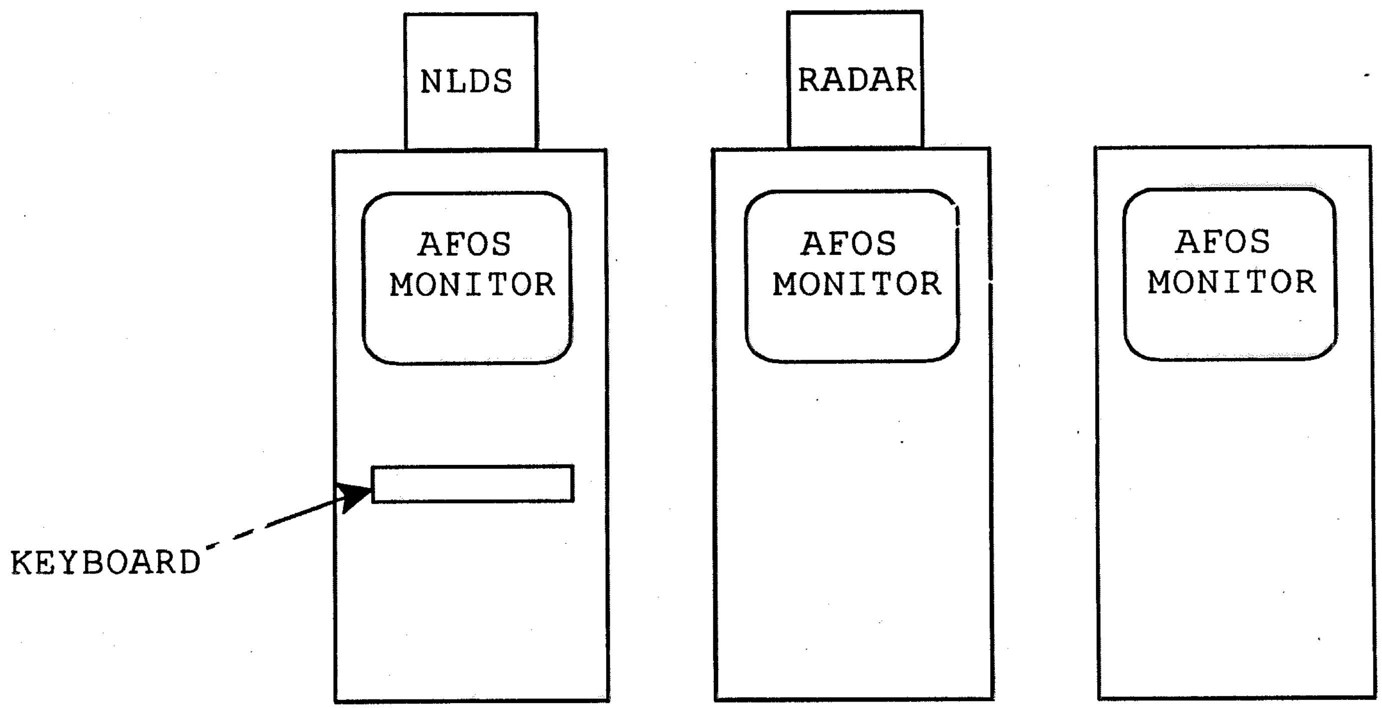


FIGURE 1b. AFOS ARRANGEMENT

forecasters primarily utilize the N-AWIPS for AFOS data and National Weather Service (NWS) model forecast data.

3.2.3 NLDN Detected Display.

The NLDS is a dedicated display consisting of a single monitor. Information on this display is strictly graphical and can only be modified or manipulated by convective forecasters. This display is used to identify cloud-to-ground lightning strikes enabling forecasters to identify areas of convective activity. Convective forecasters utilize a keyboard, mouse, and a menu driven interface to interact with the system.

3.2.4 National Radar Summary.

Similar to the lightning display, the radar display is a dedicated display consisting of a single monitor. Information on this display is graphical and cannot be modified or manipulated by the area forecasters. This display provides forecasters with precipitation information on a national scale. Since the radar display cannot be manipulated, there is no keyboard or mouse.

3.2.5 Personal Computer.

The PC consists of a monitor, keyboard, and mouse. The primary purpose of the PC is word processing for composing the text products. Software resident on the PC transmits the products. Text products transmitted are AIRMETs, SIGMETs, FAs, and International SIGMETs. These products are transmitted to the NWS database and the FAA weather database.

3.2.6 Dedicated Satellite Display.

The satellite display consists of a single monitor. The information is graphical and is not manipulated by the forecasters. The display provides forecasters with GOES 8 satellite imagery on a national scale. Satellite information is provided on the VDUC as well. The satellite display has a keypad interface. The keypad is used to select different satellite views.

3.2.7 AFOS Equipment.

The AFOS is a three-module system consisting of a keyboard and, three monitors. Data is presented in both graphics and text. Data is retrieved via a command line interface. The display provides all NWS weather products (e.g., prognosis charts, Surface Aviation Observations [SAO], Terminal Forecasts, etc.).

3.3 INTERFACES.

Not applicable.

4. EVALUATION DESCRIPTION.

4.1 SCHEDULE AND LOCATION.

The schedule and locations for the AWC Human Factors evaluation were as follows:

Evaluation Stage	Date	Location
Questionnaire	October 4-16, 1996	AWC
System Review	October 4-5, 1996	AWC
Task Analysis	October 30 - November 3, 1996	AWC
Verification	November 14-17, 1996	AWC

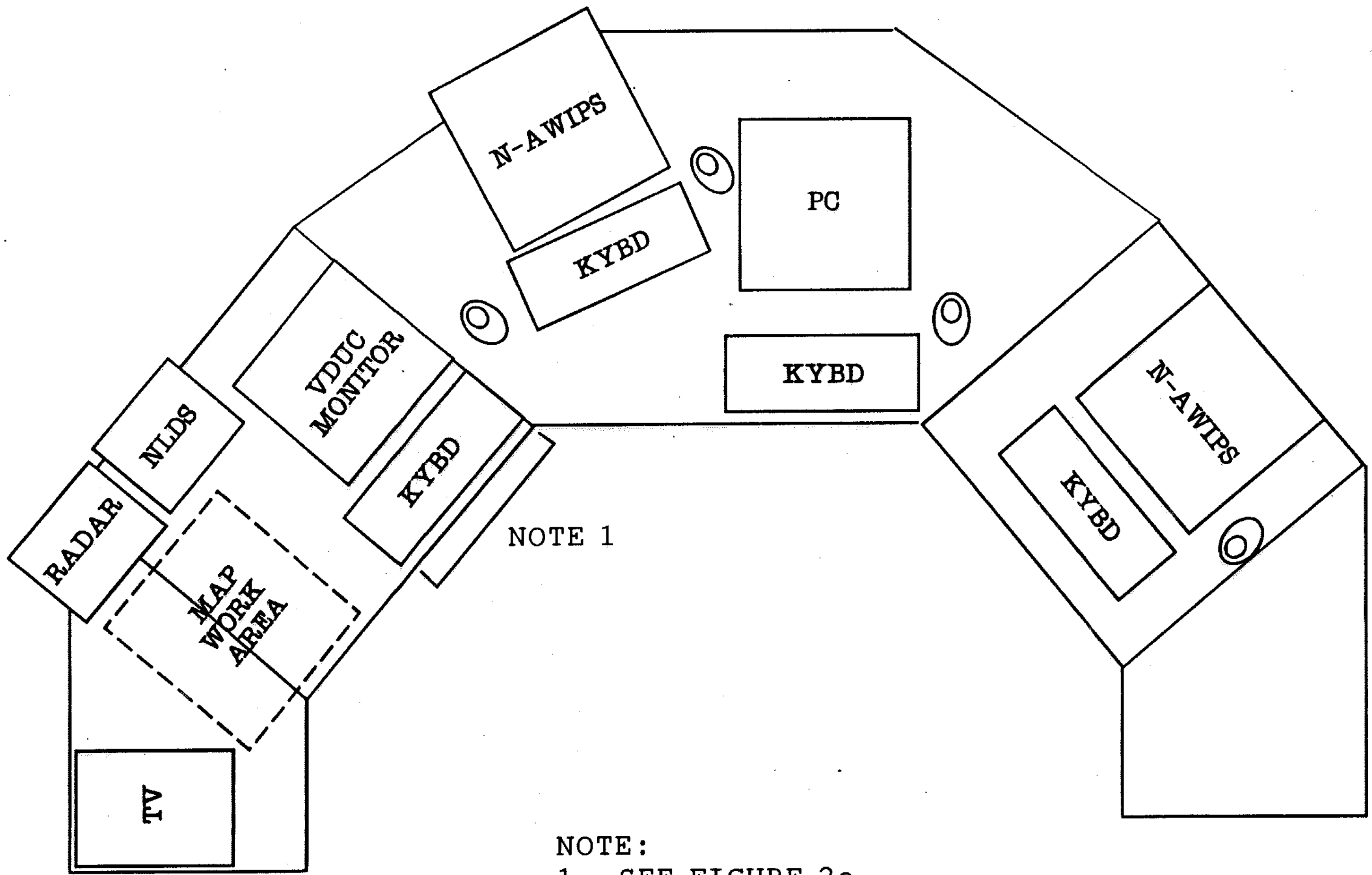
4.2 PARTICIPANTS.

Personnel from the following organizations conducted and supported the AWC Forecaster Workstation evaluation:

Organization	Role
AND-460	Managed and funded all efforts.
ACT-320	Test Director and Evaluators
AWC	Equipment, Forecasters, Supervisors, and Technical Support

4.3 SPECIALIZED EVALUATION EQUIPMENT.

The task analysis stage of the evaluation took place in the Experimental Forecast Facility (EFF) forecaster work area mockup. The mockup resembles the current forecaster work area with the exception of the AFOS equipment. The AFOS equipment will be phased out of use at the AWC; therefore, an extra N-AWIPS display was installed in place of the AFOS equipment. All systems in the mockup were operational, thus, the mockup was representative of the operational forecast stations. Figure 2 illustrates the forecaster work area mockup.



NOTE:
1. SEE FIGURE 2a

FIGURE 2. EXPERIMENTAL FORECAST FACILITY MOCKUP

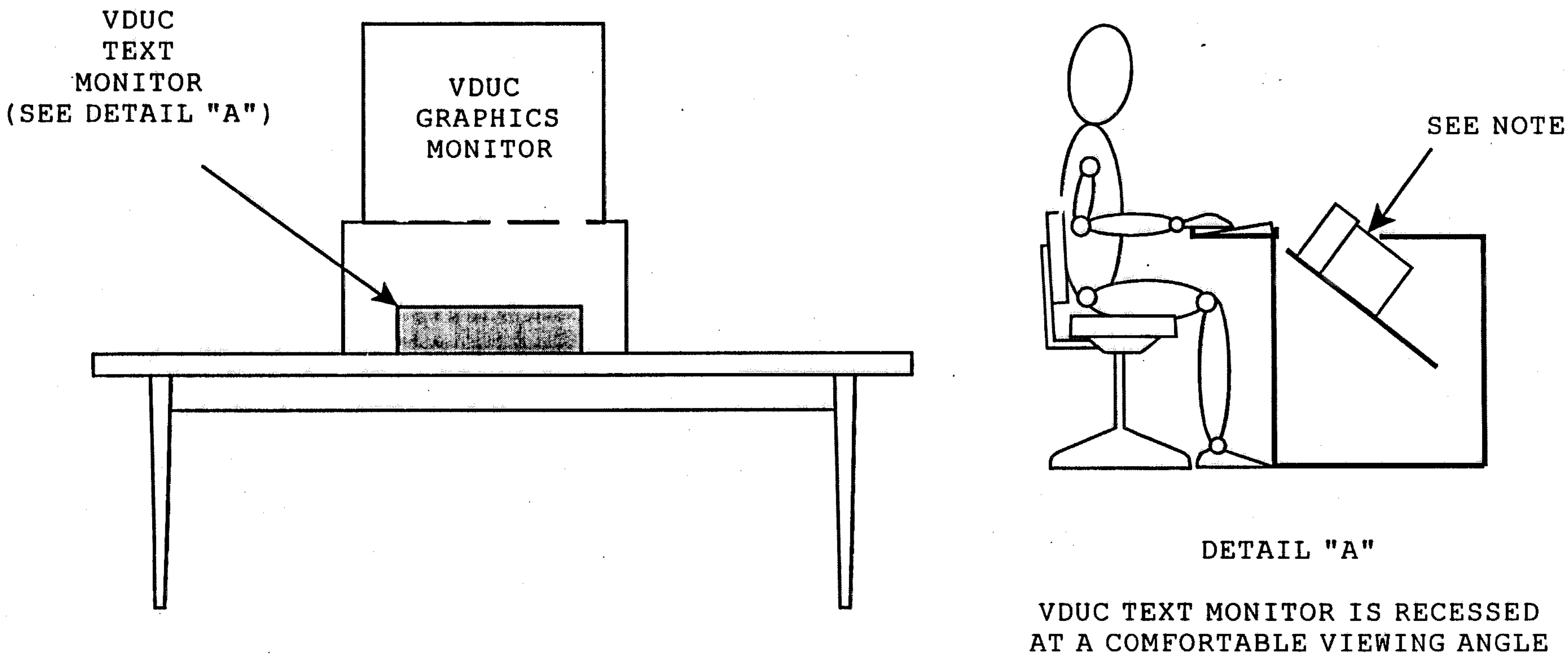


FIGURE 2a. VDUC ARRANGEMENT

4.4 EVALUATION OBJECTIVES AND CRITERIA.

The objectives of the human factors evaluation were as follows:

a. Identify aspects of the current software and hardware configuration that impose a negative impact on human performance, workload, and user satisfaction;

b. Determine an optimal physical layout or workstation design for the projected forecaster workspace; and

c. Research and recommend possible solutions for mitigating shortcomings in the current and planned designs.

AWC forecaster work areas were not considered as a system with formal design specifications. Therefore, no formal success criteria were used for the evaluation. However, in order to identify both positive and negative attributes of the forecaster work area, the following evaluation criteria were used:

a. Positive reports by forecasters concerning human performance, workload, and user satisfaction as related to system usability and workspace design; and

b. Compliance with MIL-STD-1472D and human factors engineering design standards and guidelines.

4.5 EVALUATION DESCRIPTION.

The evaluation program was a four-stage human factors evaluation of the AWC FA and convective Forecaster workspace and systems. The evaluation was designed to identify the problem areas that currently exist in the AWC FA and convective workstations. The four stages were:

a. Questionnaire administration,
b. Documentation/system review,
c. Task analysis, and
d. Verification and observation sessions.

4.5.1 Questionnaire Administration.

The purpose of the questionnaire was to identify problem areas within the AWC forecaster work area. The questionnaire was administered to forecasters prior to the start of the evaluation. The questionnaire asked forecasters to rate interface characteristics of the current AWC systems. Forecasters were given 1 week to answer the questionnaire. After the questionnaires were returned, evaluators summarized the results and outlined perceived problem areas. These problem areas were the focus of the remainder of the evaluation. The questionnaire is in appendix A.

4.5.2 Documentation/System Review.

AWC systems lacked system documentation. Therefore, a system review was conducted to gather information regarding various characteristics (e.g., interface type, information available, data presentation, data retrieval methods) of each system. An ACT-320 meteorologist conducted the system review. This review targeted information traditionally outlined in system documentation. System information was summarized according to general system information, information presentation, and system characteristics. The system information is summarized in appendix B.

4.5.3 Task Analysis.

The purpose of the task analysis was to characterize forecaster behaviors and their interactions with the workstation environment. The task analysis was utilized to reveal the impact, both positive and negative, of the current hardware and software configuration on forecaster performance and user satisfaction.

Each morning evaluators were briefed regarding current and forecasted weather conditions. Scenarios for each forecaster were chosen on the basis of daily weather conditions. During the task analysis, forecasters were instructed to complete a common job task/scenario (e.g., create an AIRMET or FA utilizing the systems in the EFF). During this session, forecasters were instructed to "think out loud" and evaluators noted all issues and problems. Following the completion of the task, forecasters further discussed any system aspects that hindered their work habits. Probe questions clarified points made during the completion of the product. Appendix C contains an illustration of the log sheets used during the evaluation.

4.5.4 Verification and Observation Sessions.

Following a review of information gathered during the task analysis, evaluators returned to AWC to conduct a followup evaluation. During this stage, evaluators observed and questioned forecasters working in their operational environment rather than the EFF in order to verify data collected in the mockup environment. Task flow diagrams and problem lists developed from the task analysis were used during the verification stage to note any discrepancies.

4.6 DATA COLLECTION AND ANALYSIS METHOD.

Questionnaire answers were tabulated and problem areas identified. System information was summarized according to general system information, information presentation, and system characteristics. Evaluators used observation log sheets during the scenarios to record forecaster activities and problems encountered during the task analysis. Evaluators summarized observation data and used this information to generate task flow diagrams, identify critical systems, and refine problem lists. Task flow diagrams and problem lists resulting from the task analysis were used during the verification portion of the evaluation.

5. RESULTS AND DISCUSSION.

This section presents the results of the evaluation.

5.1 QUESTIONNAIRE RESULTS.

The objective of the questionnaire was to identify the areas/functionalities of the systems and/or work areas that forecasters perceive as problematic. Tabulated questionnaire results and user comments are summarized in appendix D. The following problems and issues associated with forecaster work areas were identified using the questionnaire:

a. Fonts too small;

b. Menus lack organization and require excessive activation;

c. Extensive switching from keyboard to mouse;

d. Lack of feedback cues;

e. Lack of system status indicators;

f. No indication of status of transmitted messages;

g. Unlabeled function keys;

h. Inconsistent functionality of function keys across systems;

i. Poor help system (both on-line and manuals);

j. Some keyboards too high or out of reach;

k. Paper and pencil workspace area too small;

l. Too many monitors, mice, and keyboards;

m. Windows overlapping;

n. Functions not often used are difficult to relearn;

o. Cryptic error messages;

p. Lack of data entry prompting;

q. Annoying alarms;

r. Color coding requiring interpretation;

s. Transmission procedures inconsistent across products;

t. Ambient light glare.

Evaluators used this problem list to identify focus areas for the on-site evaluation.

5.2 TASK ANALYSIS RESULTS.

The task analysis was intended to determine:

a. What weather products are produced by FAs and convective forecasters;

b. Forecaster activities necessary to produce those products; and

c. Human factors problems that were regularly encountered while performing those activities.

This section provides a description of tasks and resulting aviation weather products produced by FAs and convective forecasters. In addition, the human factors problems that exist in the forecaster work area are addressed in this section.

5.2.1 Weather Product Descriptions and Associated Tasks.

Aviation forecasters produce five weather products; AIRMETs, SIGMETs, FAs, convective SIGMETs, and International SIGMETs. The tasks, task flow, systems, and displays used to develop AIRMETs and FAs are shown in figure 3. The tasks shown in the figure represent activities accomplished by forecasters. In order to simplify the task description, only development of AIRMETs and FAs are represented in the figure. Specific differences in activities for other products are noted in the respective paragraphs that discuss their development. All information enclosed in brackets in the remainder of this section refers to boxes contained within figure 3.

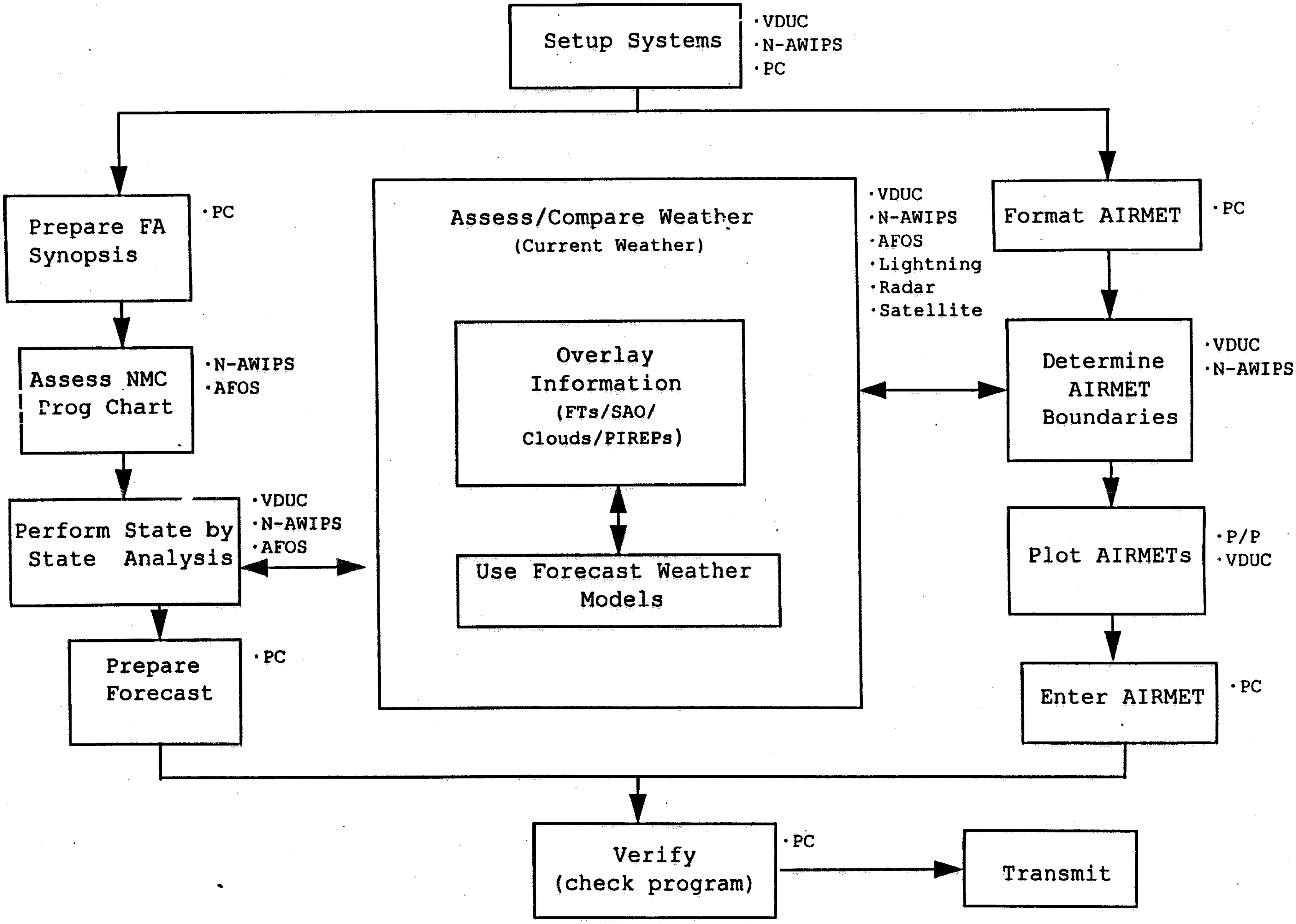


FIGURE 3. AIRMET/FA TASKS

The FA task analysis revealed that data collection and analysis activities comprise the majority of a forecaster's time and attention. Furthermore, all available systems are used almost simultaneously in order to gather the needed weather information. AIRMETs and FAs are frequently prepared during the same time frame, although in most situations they are transmitted at different times of the day.

5.2.1.1 Airmen Meteorological Statements.

5.2.1.1.1 AIRMET Descriptions.

These in-flight weather advisories are issued only to amend the area forecast and target weather phenomena that are of operational interest to all aircraft and potentially hazardous to some aircraft. AIRMETs cover moderate icing, moderate turbulence, sustained winds of 30 knots or more at the surface, widespread areas of ceilings less than 1000 feet, visibility less than 3 miles, and extensive mountain obscuration. These AIRMETs are broadcast every 6 hours.

5.2.1.1.2 AIRMET Generation.

AIRMETs are produced by FAs. FAs begin their shift by setting up the work area to accommodate their working requirements [Setup Systems]. The next step in the task sequence is to [Format the AIRMET] on their PC. Once the AIRMET has been formatted, FAs use VDUC and N-AWIPS to [Determine AIRMET Boundaries]. The iterative nature of this task is represented by the double headed arrows in figure 3. In determining AIRMET boundaries and FAs, forecasters [Assess/Compare Weather] which includes [Overlay Information] such as Terminal Forecasts (FTs), Surface Aviation Observations (SAO), satellite cloud data and PIREPs. This current weather information is superimposed on satellite data using the VDUC. FAs compare the current weather with [Forecast Weather Models] to determine which forecast model may be the most appropriate to use for developing the AIRMET boundaries.

Once AIRMET boundaries have been determined, FAs [Plot the AIRMETs], either with pencil and paper plots or interactively on the VDUC. The next step in the process is to [Enter AIRMET] on the PC. The FA then uses a resident PC program to check spelling, format, and logic of the AIRMET entries [Verify]. Once the AIRMET message has been verified and corrected, the FA [Transmits] the AIRMET to the aviation community.

5.2.1.2 Significant Meteorological Statements.

5.2.1.2.1 SIGMET Description.

A SIGMET is a weather advisory issued by FAs concerning weather significant to the safety of all aircraft. SIGMET advisories cover severe and extreme turbulence, severe icing, and widespread dust or sand storms that reduce visibility to less than 3 miles.

5.2.1.2.2 SIGMET Generation.

The SIGMETs prepared and transmitted by FAs are not specifically represented on the diagram. However, FA tasks required to produce a SIGMET are similar to those employed by FAs to produce an AIRMET. The work area hardware and software are the same. Development of a SIGMET is initiated when the FA receives an urgent PIREP indicating SIGMET conditions have been encountered. As soon as this information becomes available, the FA determines SIGMET boundaries and transmits the information to the aviation community. SIGMET transmission procedures are the same as those employed during AIRMET transmission.

5.2.1.3 Area Forecasts.

5.2.1.3.1 FA Description.

FAs are 8-hour aviation weather forecasts for an assigned area of the contiguous United States. Area forecasts contain a synoptic outlook for the forecast area as well as forecasted ceiling and visibility conditions.

5.2.1.3.2 FA Generation.

The forecaster activities for producing FAs are also represented in figure 3. As with the AIRMET tasks, the first step is to [Setup systems]. The forecaster utilizes National Meteorological Center's (NMC) Prognosis Chart [Assess NMC's Prognosis (Prog) Chart] disseminated on AFOS to [Prepare the FA Synopsis]. The forecaster then enters the synopsis into the PC. Forecasters review FTs, SAOs, and satellite imagery when [Performing State-by-State Analysis] of the weather. At this point in the process, the tasks of producing AIRMETs and FAs merge as the forecasters [Assess/Compare Weather] to develop both products. The iterative process of performing state-by-state analyses culminates in the task of [Prepare Forecast] on the PC. Forecasters then edit [Verify] and [Transmit] the FA.

5.2.1.4 Convective SIGMETs.

5.2.1.4.1 Convective SIGMET Description.

Convective SIGMETs are weather advisories concerning convective weather significant to the safety of all aircraft. For example, convective SIGMETs are issued for tornadoes, lines of thunderstorms, embedded thunderstorms of any intensity level, areas of thunderstorms greater than or equal to Video Integrator Processor (VIP) level 4 with an aerial coverage of 40 percent or more, and hail three-fourth inch or greater. These weather products are issued only by convective forecasters from the convective forecaster work area.

5.2.1.4.2 Convective SIGMET Generation.

The convective forecaster activities differ from FA activities in that they issue SIGMETs on an hourly basis. Convective forecasters do not produce AIRMETs or area forecasts. However, the task analyses indicated that they use the workstation components and process the weather information in the same manner as FAs.

5.2.1.5 International SIGMETs.

5.2.1.5.1 International SIGMET.

International SIGMETs are broadcast for waters beyond the U.S. coastal water boundaries. International SIGMETs are issued primarily for convective activity and turbulence. International SIGMETs are issued by convective forecasters during the winter months and by FAs during the summer months.

5.2.1.5.2 International SIGMET Generation.

International SIGMETs are generated similar to convective SIGMETs and AIRMETs.

5.2.2 Problems.

The task analysis revealed numerous human factors issues related to the FA work area as well as the weather systems and their interfaces. Table 1 outlines the human factors shortcomings noted. Problems are grouped according to system and physical workspace. Observations related to the problem are also listed in the table.

TABLE 1. PROBLEM CLASSIFICATIONS

PROBLEM	OBSERVATION
N-AWIPS	
1. Font size too small.	Displays hard to read; user stretching to see screen.
2. Menus: not logically organized; strings and scripts are difficult to remember; unfamiliar abbreviations.	Users not fully utilizing N-AWIPS capability; reported slower performance while trying to locate data files.
3. Display: slider bars are small and hard to manipulate.	User expending extra effort to place and manipulate the cursor.
4. Display: organization of display functions (widely dispersed over the display).	User complaint: accessing consecutive functions requires moving cursor to opposite corners of display and back.
5. Initiating loops can be tedious.	User complaint; requires extensive cursor movement.
6. No system status report when the system is working/busy.	User did not know whether system was processing data or had not accepted data entry input.
7. Buttons (AFOS text) do not always activate on first depression.	User reported that it was possible to continue operation without knowledge of data entry failure.
8. Cannot zoom in on model data in NTRANS mode.	User complaint; labor intensive to move to GEMPAK.
9. Excessive data entry string required to access SAOs on N-AWIPS; this is not required on the AFOS system.	User utilized mouse to access AFOS; preferred keyboard entry if string were not so long.
10. Must exit out of GEMPAK (cannot run other models concurrently), otherwise GEMPAK will run in all the windows.	User complaint that GEMPAK would run in all other applications, if they forgot to exit.

TABLE 1. PROBLEM CLASSIFICATIONS (Continued)

PROBLEM	OBSERVATION
11. No station identifier overlays available.	User would like to overlay station identifiers on N-AWIPS.
PC	
12. No lists of available macros or standard formats; no list of quick key short cuts.	Users at EFF had trouble remembering how to call up macros; could not remember quick key short cuts.
VDUC	
13. Poor menu organization, tablets/menus not in logical order (e.g., alphabetical or weather type); no help files or look-up tables.	Users at EFF had trouble locating application/data needed.
14. Command line obscured by desk position (EFF).	Users had to stretch to see command line because it was set too low in workstation.
15. No system status information when there are processing delays.	User did not know that system was processing data or had not accepted data entry input.
16. Convective - Not enough interactive capability (e.g., zoom satellite).	User complaint; would like to be able to zoom in on satellite display.
17. Convective - Cannot blank out image to read overlay data.	Overlay data was hard to read because of background image.
18. Function keys on Tower and Wide Word computers differ.	User had trouble efficiently accommodating the change from the system he was used to.
19. FA positions would like to be able to be able to interact VDUC with PC for plotting AIRMETs.	This capability is available at the convective workstation but not on the FA VDUC systems.
WORKSPACE	
20. Keyboards on table are too high for regular use.	User has to reach to use keyboard on desktop.

TABLE 1. PROBLEM CLASSIFICATION (Continued)

PROBLEM	OBSERVATION
21. Not enough workspace for paper and pencil plotting weather or placing printouts for reference.	Excessive movement; FA has to roll back and forth from open workspace to displays.
22. Too many monitors, mice, and keyboards on desktop.	Keyboards and mice on desktop clutter space and make it difficult to quickly access the appropriate device.
23. Not enough monitor space available for all the information needed; need to printout products - no place to place them for easy reference.	Paper printouts frequently laid on top of keyboards or otherwise cluttering work area.
MISC	
24. Systems not utilized fully due to insufficient training or help functions.	Sometimes FAs did not use a system capability because they were uncertain about how to use it.
25. Scripts and functions inconsistent across systems.	Caused some difficulty for FAs who used one system after working on another system.

6. CONCLUSIONS/RECOMMENDATIONS.

The following section discusses conclusions and recommendations stemming from the results of the Aviation Weather Center (AWC) human factors evaluation.

6.1 PROBLEM SPECIFIC RECOMMENDATIONS AND SOLUTIONS.

Table 2 presents recommendations and solutions to the problems observed during the human factors evaluation of the AWC work area. The table contains problems and observations as listed in table 1 along with recommendations and solutions to the problems. The feasibility and cost of incorporating each recommendation and/or solution are not assessed.

The following discussion outlines some recommendations from table 2 in greater detail.

a. Problem 2, Menu Organization: Currently, menus on both the Visual Infrared Spin Scan Radiometer (VISSR) Atmospheric Sounder (VAS) Data Utilization Center (VDUC) and National Centers for Environmental Prediction Advanced Weather Interactive Processing System (N-AWIPS) are poorly organized. Many times, forecasters had to search through the menu to find the appropriate option; thus, increasing response time and workload. Menus should be organized according to functionality, and options most commonly utilized should appear first in the list. Additionally, any titles abbreviated in the menu should be defined in either on-line help or reference cards. At times, these abbreviations caused uncertainty in the forecasters' selection process.

b. Problem 5, Looping Sequence: The buttons and menus required to initiate a looping sequence on the N-AWIPS are widely dispersed over the display. Such organization leads to labor intensive initiation of a looping sequence. Buttons and menus utilized to initiate a loop should be clustered to make the task more efficient.

TABLE 2. RECOMMENDATIONS/SOLUTIONS

PROBLEM	OBSERVATION	RECOMMENDATION
N-AWIPS		
1. Font size too small.	Displays hard to read; user stretching to see screen.	Install larger more readable font.
2. Menus: not logically organized; strings and scripts are difficult to remember; unfamiliar abbreviations.	Users not fully utilizing N-AWIPS capability; reported slower performance while trying to locate data files.	Design menu structure according to logical function, frequency, and criticality of use; determine user guidance needs; provide documentation and usable on-line help screens; make hard copy reference cards available (See paragraph 6.2 for additional information).
3. Display: slider bars are small and hard to manipulate.	User expending extra effort to place and manipulate the cursor.	Slider bars should be larger.
4. Display: organization of display functions (widely dispersed over the display).	User complaint: accessing consecutive functions requires moving cursor to opposite corners of display and back.	Redesign display to cluster functions to require minimal data entry (cursor) action.
5. Initiating loops can be tedious.	User complaint: requires extensive cursor movement.	All buttons/menus associated with looping initiation should be located in one corner or area of the display (See paragraph 6.2 for additional information).
6. No system status report when the system is working/busy but delayed.	User did not know whether system was processing data or had not accepted data entry input.	Status information on current data processing should be available at all times, automatically or by request; Status indicator should be implemented or improved.

TABLE 2. RECOMMENDATIONS/SOLUTIONS (Continued)

PROBLEM	OBSERVATION	RECOMMENDATION
7. Buttons (AFOS text) do not always activate on first depression.	User reported that it was possible to continue operation without knowledge of data entry failure.	Increase button sensitivity.
8. Cannot zoom in on model data.	User complaint: labor intensive to move to GEMPAK.	Implement new functionality.
9. Excessive data entry string required to access SAOs on N-AWIPS; this is not required on the AFOS system.	User used mouse to access AFOS; preferred keyboard entry if string were not so long.	Require N-AWIPS to emulate AFOS data strings.
10. Must exit out of GEMPAK (cannot run other models concurrently), otherwise GEMPAK will run in all the windows.	User complaint that GEMPAK would run in all other applications, if they forgot to exit.	Modify system to overcome problem; at minimum, prompt user to exit GEMPAK if user attempts to change modes without exiting.
11. No VOR points available.	User would like to overlay station identifiers on N-AWIPS.	Implement station identifier overlay.
PC		
12. No lists of available macros or standard formats; no list of quick key short cuts.	Users at EFF had trouble remembering how to call up macros; could not remember quick key short cuts.	Establish user guidance needs; Provide documentation and usable on-line help screens; Hard copy reference cards available at all stations.

TABLE 2. RECOMMENDATIONS/SOLUTIONS (Continued)

PROBLEM	OBSERVATION	RECOMMENDATION
VDUC		
13. Poor menu organization, tablets/menus not in logical order (e.g., alphabetical or weather type); no help files or look-up tables.	Uses at EFF had trouble locating application/data needed.	Design menu structure according to logical function, frequency, and criticality of use; Determine user guidance needs; provide documentation and usable on-line help screens; make hard copy reference cards available (See paragraph 6.2 for additional information).
14. Command line obscured by desk position (EFF).	Users had to stretch to see command line because it was set too low in the workstation.	Continued awareness for new workstation that the VDUC text screen not be placed too low in the console.
15. No system status information when there are processing delays.	User did not know that the system was processing data or had not accepted data entry input.	Status information on current data processing should be available at all times, automatically or by request.
16. Convective - Not enough interactive capability (e.g., zoom satellite).	User complaint: would like to be able to zoom in on satellite display.	Determine need for this capability in convective.
17. Convective - Cannot blank out image to read overlay data.	Overlay data was hard to read because of background image.	Provide on/off toggle capability.
18. Function keys on Tower and Wide Word computers differ.	User had trouble efficiently accommodating the change from the system he was used to.	Make all function keys consistent; at minimum, label tower and wide word systems and note functional differences off-line (See paragraph 6.2 for additional information).

TABLE 2. RECOMMENDATIONS/SOLUTIONS (Continued)

PROBLEM	OBSERVATION	RECOMMENDATION
19. FA positions would like to be able to interactively plot AIRMETs with VDUC and PC.	This capability is available at the convective workstation but not on the FA VDUC systems.	Install this capability on FA VDUCs.
WORKSPACE		
20. Keyboards on table are too high for regular use.	User has to reach to use keyboard on desktop.	N-AWIPS keyboards should be no higher than 27" from floor; install keyboard trays under work table.
21. Not enough workspace for paper and pencil plotting weather or placing printouts for reference; Too many monitors, mice, and keyboards on desktop.	Excessive movement; FA has to roll back and forth from open workspace to displays. Keyboards and mice on desktop clutter space and make it difficult to quickly access the appropriate device.	Remove N-AWIPS keyboards and mice from table top; examine the feasibility of replacing keyboards and mice with trackball keyboards for N-AWIPS.
22. Not enough monitor space available for information needed; need to printout products - no place to place them for easy reference.	Paper printouts frequently laid on top of keyboards or otherwise cluttering work area.	Computer mounted copy holders attached to a computer to hold printouts.
MISC		
23. Systems not utilized fully due to insufficient training or help functions.	Sometimes FAs did not use a system capability because they were uncertain about how to use it.	Study user capability, provide sufficient training; design on-line help; provide user documentation, hard copy reference cards.
24. Scripts and functions inconsistent across systems.	Caused some difficulty for FAs using one system after working on another system.	Standardize systems where ever possible.

c. Problem 13, Reference Tools: Forecasters have little to no reference tools available to them. On-line help should be developed that is tailored to forecaster needs. Forecasters should be polled regarding the type of information they would like to see on-line. Additionally, off-line help should be developed as well. Specifically, reference cards should be developed for each system. These cards should contain:

1. Definitions for rarely used acronyms/ abbreviations;

2. Quick key and function key definitions;

3. Procedures for rarely used features; and

4. Notes regarding functional differences across systems (e.g., Tower VDUC vs. Wide Word VDUC).

e. Problem 18, Function Key Consistency: The functionality of all function keys should be consistent. If function keys cannot be reprogrammed, they should at least be labeled to reduce confusion. Functional differences between the Tower and Wide Word VDUCs should be noted.

6.2 PROPOSED WORKSPACE.

Figure 4 is an illustration of a suggested workspace designed for future forecaster work areas. The proposed workspace design was based on human factors issues identified during the evaluation and published human factors design principles. Table 3 defines the equipment and notes any special considerations in the placement of that equipment. As with any new design, the workspace should be evaluated for forecaster comfort and efficiency.

Equipment is organized according to criticality; thus, systems most often used are centrally located. Three keyboards are located on slide-out trays. The utility of the trays is two-fold. First, the keyboards are removed from the workspace, thus, decreasing workspace clutter. Second, the keyboard trays are adjustable for height and angle, increasing the comfort and reducing muscle strain. These improvements could lead to a reduction in cumulative trauma or Repetitive Motion Injury (RMI). All mice are located directly to the right of the display so as to form a one-to-one mapping with the display. The mice can be placed to the left of each display for the left-handed user. Additionally, mice can be replaced with trackballs as they require less space to manipulate than mice.

EQUIPMENT No.	EQUIPMENT NAME
1	N-AWIPS KEYBOARD
2	PC KEYBOARD
3	VDUC KEYBOARD
4	N-AWIPS KEYBOARD
5	VDUC MONITOR
6	VDUC MONITOR
7	N-AWIPS MONITOR
8	PC MONITOR
9	N-AWIPS MONITOR
10	PRINTER
11	SHELF UNIT
12	SATELLITE DISPLAY
13	RADAR DISPLAY
14	LIGHTNING DISPLAY
15	LARGE MAP AREA
16	PRIMARY ANALYSIS ARE
17	PRIMARY PLOTTING AR
M	MOUSE

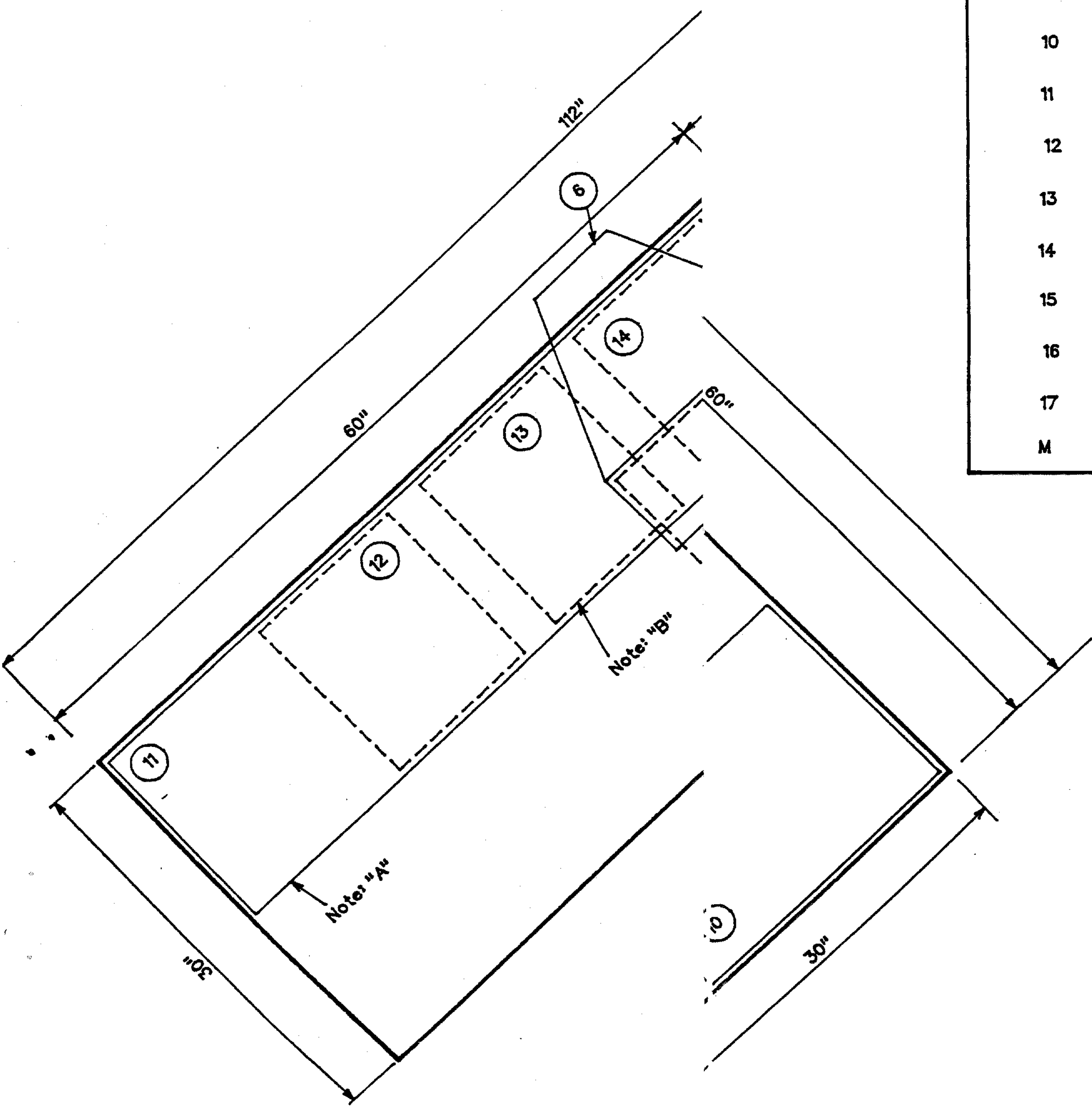


TABLE 3. PROPOSED WORKSPACE CONSIDERATIONS

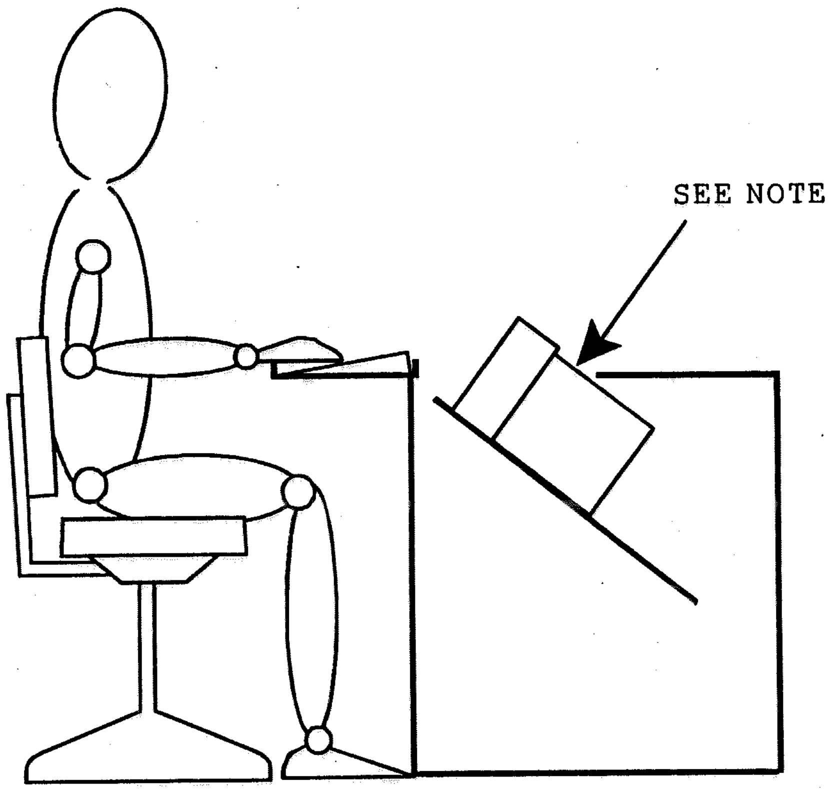
EQUIPMENT NUMBER	EQUIPMENT NAME	SPECIAL CONSIDERATIONS OR REQUIREMENTS
1	N-AWIPS Keyboard	Located on table top.
2	PC Keyboard	Located on slide-out tray 27" from floor with +/- 1" adjustability.
3	VDUC Keyboard	Located on slide-out tray 27" from floor with +/- 1" adjustability.
4	N-AWIPS Keyboard	Located on slide-out tray 27" from floor with +/- 1" adjustability.
5	VDUC monitor	Recessed in desk at comfortable angle.
6	VDUC Monitor	
7	N-AWIPS Monitor	Angled inward for comfortable viewing angle.
8	PC Monitor	Centrally located. Primary focus of forecaster.
9	N-AWIPS Monitor	Recessed in desk at comfortable angle.
10	Printer	
11	Shelf Unit	Elevated unit 30" x 15" x 22" (dependent on height of VDUC monitor). Can be equipped with slide-out keyboard trays for NLDS keyboard in convective. Shelf has down tilt to orient monitors for direct line of sight.
12	Satellite Display	Located on shelf unit.
13	Radar Display	Located on shelf unit.
14	Lightning Display	Located on shelf unit.
15	Large Map Area	Free standing map hanger.
16	Primary Analysis Area	Primary workspace for map analysis.
17	Primary Plotting Area	Primary workspace for product analysis and from line creation.

One N-AWIPS monitor and one VDUC monitor (see #5 and #9 on figure 4, respectively) are recessed into the desk in order to reduce neck strain and increase viewing comfort, specifically for individuals wearing bifocal corrective lenses. Figure 5 illustrates a recessed monitor. It is important to note, however, that all portions of the display should be easily viewable from a comfortable seated position.

Available free space has been increased to facilitate the analyzing of maps and plotting "from" lines. A copy holder has been attached to the PC to improve the transition of information from paper to PC or to hang paper plots for easier referencing. The large map holder is located behind the workspace and is easily visible from the seated position. The elevated shelf unit holds the satellite, radar, and lightning displays. This shelf unit has a down tilt angle in order to form a direct line of sight to the monitor from the seated position; thus reducing neck strain when viewing the elevated displays.

6.3 SUMMARY.

The evaluation of the AWC work area revealed several issues that impact the performance, comfort, and workload of forecasters. Under good weather conditions, most work area problems are easily overcome and are sometimes no more than minor annoyances. However, when a forecaster is responsible for preparing weather advisories for areas that are experiencing severe weather conditions, the impact of awkward workspace arrangement, poorly organized menu systems, or the need for excessive control actions can create considerable unnecessary task loading. This is especially true when he/she has been away from the position for a few days or longer. This increased task loading may result in slowed performance, errors, and unnecessary job stress and discomfort. Given the requirement for timeliness in the forecaster's tasks, care should be taken to resolve any problems that may hinder performance or increase workload. Implementation of recommended solutions as well as an ergonomically designed workspace should provide forecasters with a future work area that shows improvement over the current configuration.



NOTE:
VDUC TEXT MONITOR IS RECESSED
AT AN ADJUSTABLE VIEWING ANGLE
(25° - 35°)

FIGURE 5. RECESSED MONITOR

7. ACRONYMS.

AFOS	-	Automated Family of Service
AFOTEC	-	Air Force Operational Test and Evaluation Center
AIRMET	-	Airmen Meteorological Statement
AWC	-	Aviation Weather Center
AVN	-	Aviation Model
CWSU	-	Center Weather Service Unit
EFF	-	Experimental Forecast Facility
FA	-	Area Forecast
FAA	-	Federal Aviation Administration
FT	-	Terminal Forecast
LFM	-	Limited Area Fine Mesh Model
MOS	-	Model Output Statistics
MRF	-	Medium Range Forecast
N-AWIPS	-	NCEP Advanced Weather Integrated Processing System
NCEP	-	National Centers for Environmental Prediction
NEXRAD	-	Next Generation Radar
NGM	-	Nested Grid Model
NLDS	-	National Lightning Detection System
NMC	-	National Meteorological Center
NWS	-	National Weather Service
PC	-	Personal Computer
PIREP	-	Pilot Report
RMI	-	Repetitive Motion Injury
RUC	-	Rapid Update Cycle
SAO	-	Surface Aviation Observation
SELS	-	Severe Local Storms
SIGMET	-	Significant Meteorological Statement
TKE	-	Turbulent Kinetic Energy
VAS	-	VISSR Atmospheric Sounder
VDUC	-	VAS Data Utilization Center
VISSR	-	Visual Infrared Spin Scan Radiometer
VOR	-	Very High Frequency Omnidirectional Range

APPENDIX A

AWC PRELIMINARY QUESTIONNAIRE

Preliminary Questionnaire

FAA Technical Center personnel are conducting a human factors evaluation of the Aviation Weather Center (AWC) forecaster's work area. This evaluation will identify problem areas with current displays/systems and workspace layout in addition to providing information to aid in the development of future forecaster work areas and systems.

The purpose of the questionnaire is to provide evaluators with an introduction to current problem areas. Your questionnaire responses will allow evaluators to focus evaluation efforts on the most prominent problem areas.

Responses to this questionnaire will remain ANONYMOUS and CONFIDENTIAL. A report will be written incorporating the results of this questionnaire, summarizing respondents comments; however, no one will be identified or associated with any specific comment.

Instructions

Please read each statement carefully. Consider the entire work area/space, including all displays/systems (i.e., VDUC, N-AWIPs, AFOS, word processing, national lightning, national radar, satellite imagery) when determining your response. Remember to consider display/system characteristics rarely utilized as well as characteristics utilized daily.

Place an 'X' next to the appropriate response. If your response is "sometimes" or "never," please explain the situation(s) in which the statement is **not** satisfied. Remember to identify the specific system(s). Please be as detailed as possible in your explanations. Note problems even if they don't exist on every system as we are trying to identify specific problem areas for each system. For example, if a statement is true for all systems **except** the VDUC then mark "sometimes" and explain the problem associated with the VDUC.

1. The user is adequately prompted when data entry is required.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking: ______________________

____

____

____

2. Function keys and hot keys are adequately labeled.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking: ______________________

____

____

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3. Alarms are distinctive and easy to notice.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking: ______________________

____

____

____

4. It is easy to acknowledge and turn off an alarm after its alerting purpose has been served.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking: ______________________

5. Auditory alarms are effective in directing the user's attention to critical conditions, but do not interfere with other operations.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking: ______________________

6. Functions that the user has not performed for a period of time are easily relearned.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking: ______________________

7. Sufficient help (on-line, manuals) exists for functions not easily relearned.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking:______________________

8. Input devices (e.g., keyboard, cursor, mouse, or joystick) are appropriate for the tasks being performed.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking:______________________

9. Data entry is user-paced, rather than system-paced.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking:______________________

10. Text inputs are easy to edit.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never**," please provide an example of where the feature is lacking: ________________

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____

____

11. Data entry requires a minimal number of steps.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never**," please provide an example of where the feature is lacking: ________________

____

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12. The system provides quick, positive feedback on the acceptance or rejection of data entry.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never**," please provide an example of where the feature is lacking: ________________

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13. Where the system requires substantial time to process a data entry, there is an adequate "PROCESSING" or "WORKING" message.

___ Always　　___ Sometimes　　___ Never　　___ N/A

For a response of **"Sometimes" or "Never,"** please provide an example of where the feature is lacking: ____________________

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14. When a data entry error is detected, the system provides adequate guidance on how to correct the error.

___ Always　　___ Sometimes　　___ Never　　___ N/A

For a response of **"Sometimes" or "Never,"** please provide an example of where the feature is lacking: ____________________

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15. The system minimizes shifting from mouse to keyboard inputs.

___ Always　　___ Sometimes　　___ Never　　___ N/A

For a response of **"Sometimes" or "Never,"** please provide an example of where the feature is lacking: ____________________

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____

____

16. It is easy to follow data that are displayed over multiple pages.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking: ____________________

17. Data displays minimize the requirement for memorization or interpretation.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking: ____________________

18. Display update rate is fast enough to keep pace with user and system actions.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking: ____________________

19. Text displays are easy to read.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking: ______________________________

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20. The method for controlling windows is consistent across displays.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking: ______________________________

____

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____

21. Window overlays are situated so that they do not obscure important information.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking: ______________________________

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____

22. Where several windows are displayed simultaneously, it is easy for the user to shift among them to select which window is to be made active.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking:____________________

____

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____

23. Data updates can be controlled by the user.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking:____________________

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____

24. Where there are several possible modes of operation (e.g., EDIT, MONITOR), the user knows what mode he is currently in.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking:____________________

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____

____

25. It is easy to activate the desired menu option.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking: ______________________

____

____

____

26. The menu hierarchy is organized so that critical or frequently used options are easy to select.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking: ______________________

____

____

____

27. It is easy to move among different levels of the menu hierarchy.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking: ______________________

____

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____

28. The assignment of functions to function keys is consistent across different operations.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking:________________________

____

____

____

29. Wording of command language is consistent across different functions.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking:________________________

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____

30. Command language is easy to edit.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking:________________________

____

____

____

31. Procedures for preparing, sending, and receiving messages are consistent across systems.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking:______________________________

____

____

____

32. Users can interrupt and return to message preparation tasks without data loss.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking:______________________________

____

____

____

33. If user is sending a batch of messages, the user can defer transmission until all messages are complete.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking:______________________________

____

____

____

34. Text is automatically formatted for standard products (e.g., AIRMETs).

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking:___

35. The user is provided adequate status information on transmitted messages.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking:___

36. Data transmission procedures for composing messages are compatible with general data entry procedures (e.g., word processing procedures).

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking:___

37. Most frequently used displays are located centrally for easy viewing.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking: ______________________

____

____

____

38. Displays are arranged according to their sequence of use or functional relations.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking: ______________________

____

____

____

39. All systems/monitors/keyboards are within reach of the seated operator.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking: ______________________

____

____

____

40. Monitors are located at an appropriate height so that the user can comfortably view monitors (i.e., users don't have to look up or look down excessively).

___ Always　　___ Sometimes　　___ Never　　___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking:______________________________

41. The viewing distance from the display to the seated operator is comfortable.

___ Always　　___ Sometimes　　___ Never　　___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking:______________________________

42. Chairs are adjustable to ensure users' can comfortably access the workspace (i.e., keyboards, mice, work table).

___ Always　　___ Sometimes　　___ Never　　___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking:______________________________

43. Workspace lighting minimizes display glare.

___ Always ___ Sometimes ___ Never ___ N/A

For a response of "**Sometimes**" **or** "**Never,**" please provide an example of where the feature is lacking: ________________________

____

____

____

General Comments

1. Please explain any additional system interface problems (i.e., menu structure, help system, data presentation) not addressed in the previous questions. ________________________

____

____

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2. Please explain any additional workspace layout problems (i.e., desk height, display location, chair characteristics) not addressed in the previous questions. ________________________

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3. Please feel free to provide any additional comments regarding your displays/systems and physical work environment. ____________

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Thank you for your time and cooperation. Your comments will provide valuable information for our human factors evaluation of the forecaster's work area.

APPENDIX B

SYSTEM REVIEW INFORMATION

SYSTEM: Personal Computer (PC)

CONFIGURATION: 1 display,
1 keyboard,
1 mouse

FUNCTIONS: Word processing to compose text messages (area forecasts, AIRMETs, and SIGMETs) and transmit messages.

INFORMATION PROVIDED: None.

INFORMATION FORMAT: Text.

INFORMATION RETRIEVAL: Keyboard and mouse. Majority of text composition involves keyboard.

INTERFACE TYPE: MS Windows.

MODES OR ACTIONS: Transmission of text messages.

DATA TRANSMISSION FUNCTIONS: Transmission of text messages.

SYSTEM: Lightning Display.

CONFIGURATION: 1 display,
1 keyboard located at convective SIGMET position,
Area forecasters have no control over display.

FUNCTIONS: Identifies cloud to ground lightning strikes.
Enables forecaster to identify convective areas.

INFORMATION PROVIDED: Cloud to ground lightning strike locations over conus. Data is provided by private vendor, Geomet Data Services, Inc.

INFORMATION FORMAT: Graphics.

INFORMATION RETRIEVAL: Keyboard for convective SIGMET position only.

INTERFACE TYPE: Menu driven. F2 key displays menu. Selections are made via keyboard for menu options.

MODES OR ACTIONS: Retrieval of lightning data,
Monitoring of lightning data,
Transfer of lightning data in-house to N-AWIPs for display and VDUC for overlay on satellite image.

DATA TRANSMISSION FUNCTIONS: Transmission to N-AWIPS and VDUC.

SYSTEM: WSI NOWRAD radar display

CONFIGURATION: 1 display at each forecaster area. No forecaster interaction.

FUNCTIONS: Display national composite weather radar data. Used to identify precipitation areas. Gives a general overview and a quick reference to significant weather.

INFORMATION PROVIDED: Vendor supplied national composite of NWS radar data. Six contoured reflectivity areas corresponding to different intensities of precipitation. Automatic looping capability which shows six latest 15 minute updates.

INFORMATION FORMAT: Graphics.

INFORMATION RETRIEVAL: None. Entirely automated. Radar data is processed by VDUC system and displayed on forecaster area monitors.

INTERFACE TYPE: None.

MODES OR ACTIONS: Data monitoring.

DATA TRANSMISSION FUNCTIONS: None.

SYSTEM: Satellite Display.

CONFIGURATION: 1 black and white display, no forecaster interaction.

FUNCTIONS: Display satellite images to give forecasters an overall, large-scale, picture of weather systems.

INFORMATION PROVIDED: Satellite images (visible and infrared) from NWS weather satellites.
Automatic looping of hourly images.

INFORMATION FORMAT: Graphics.

INFORMATION RETRIEVAL: None. Entirely automated. Satellite images are processed by VDUC and displayed on forecaster area monitors.

INTERFACE TYPE: None.

MODES OR ACTIONS: Data monitoring.

DATA TRANSMISSION FUNCTIONS: None.

SYSTEM: VDUC

CONFIGURATION: One graphics display monitor,
One text display monitor,
One keyboard,
One 2-button mouse.

FUNCTIONS: Display various types of weather data in order for forecaster to view current weather and forecasted weather.
Main forecaster use is overlaying of observations and forecasted weather data on satellite images.

INFORMATION PROVIDED:

Satellite images from NWS satellites,
Observations:
Radar (national and preselected regional composites),
Lightning,
PIREPS,
Profiler winds,
Skew-Ts (vertical profile of weather data at a location),
Graphical depiction of clouds at individual locations.
NWS model forecast data (Not used, N-AWIPS used instead),
NWS terminal forecasts,
Overlay of observations on satellite images identifies IFR areas,
Looping of images is possible using forecaster inputs.

INFORMATION FORMAT: Graphics and text. Graphics used most of the time. Forecasters tend to display latest satellite image and leave image on display, only changing by overlaying additional data.

INFORMATION RETRIEVAL: Keyboard and mouse. Keyboard has "hot" keys programmed. Keyboard used predominantly by entering data requests on command line.

INTERFACE TYPE: Command line and menu, forecaster has option of using either.
OS/2 operating system.

MODES OR ACTIONS: Retrieval,
Monitoring,
Contouring (forecaster specified).

DATA TRANSMISSION FUNCTIONS:	Convective forecaster may transmit geographical points identifying boundaries of SIGMETs to PC. Area forecasters can transmit to VDUC text monitor using point and click capability of graphical monitor.

SYSTEM: N-AWIPS.

CONFIGURATION: Two separate non-integrated systems each consisting of:

One display monitor,
One keyboard,
One mouse.

FUNCTIONS: Display AFOS data (observations, terminal forecasts) and NWS model forecast data in order to prepare forecast products.

INFORMATION PROVIDED: Model forecast data: See separate sheet.
AFOS (SAOs, FTs, PIREPs),
AFOS graphics,
Satellite (can overlay with PIREPs).
Can loop model data.

INFORMATION FORMAT: Graphics and text.

INFORMATION RETRIEVAL: Keyboard and mouse.
Predominantly mouse controlled.

INTERFACE TYPE: Menu driven,
Xwindows.

MODES OR ACTIONS: Data retrieval,
Data monitoring,
Contouring (forecaster specified).

DATA TRANSMISSION FUNCTIONS: None.

Model Forecast Data provided by N-AWIPS:

AVIATION MODEL (AVN)

- 850 and 500 mb heights, vorticity, and winds,
- Lifted Index (Stability index for convective forecasting),
- Mean sea level pressure,
- 1000-700 mb wind shear,
- Icing potential,
- A Severe Local Storms (SELS) package consisting of various convective parameters to identify regions of forecasted convective activity,
- A North Pacific package consisting of:
    -- Winds at 700, 500, 400, 300, 250, and 200 mb,
    -- Turbulent kinetic energy (TKE) and ellrod index (both used to forecast turbulence potential) at the 400-500, 300-400, 250-300, and 200-250 mb layers,
    -- Lifted Index and K Index (stability indices for convective forecasting),
- A North Atlantic package (same as North Pacific),
- 72 hour forecast package of:
    -- 500 mb hemispheric heights and vorticity,
    -- Mean sea level pressure,
    -- 1000-500 mb thickness,
    -- 12 hour total accumulated precipitation,
    -- Surface temperatures,
    -- Lifted index.

NESTED GRID MODEL (NGM):

- Winds at 850, 700, 500, 400, 300, 250, and 200 mb levels,
- TKE at 400-500, 300-400, 250-300, and 200-250 mb layers,
- Height contours at 850, 700, and 500 mb,
- Vorticity contours at 500 mb,
- Mean sea level pressure,
- Surface temperature and dewpoint temperature,
- 850 mb convergence and 250 mb divergence,
- 12 hour total accumulated precipitation,
- Vertical velocity at 700 and 500 mb,
- Boundary layer winds,
- Lifted index and K index,
- 1000-700 mb wind shear.

ETA MODEL (80 km resolution):

- Winds and heights at 850, 700, 500, 400, 300, 250, and 200 mb levels,
- TKE at 400-500, 300-400, 250-300, and 200-250 mb layers,
- Convective stability indices,
- Vorticity at 500 mb,
- Boundary layer winds, temperature, and dewpoint temperature,
- Low level convergence and upper level divergence,
- Vertical velocity,
- Upper level relative humidity,
- Mixing ratio,
- Icing potential:
    - -- All icing areas, low, mid, and high areas,
    - -- Bases and tops for the combined and individual categories of the icing algorithm (stable, unstable, freezing rain, and freezing drizzle),
    - -- Freezing level,
- Ellrod index at 400-500, 300-400, 250-300, and 200-250 mb layers,
- Clouds and Weather (automated, developmental tool):
    - -- Low clouds,
    - -- Mid level clouds,
    - -- Bases of clouds,
    - -- Visibility,
- Cloud bases and tops using icing algorithm,
- Temperatures at 1000, 950, 850, 700, 500, 300, and 250 mb levels,
- Relative humidity at 1000, 950, 900, 850, 800, 750, 700, 650, 600, 550, and 500 mb levels,
- SELS package (see AVIATION MODEL).

MESO ETA MODEL (29 km resolution):

- Winds and heights (same as ETA MODEL),
- TKE (same as ETA MODEL),
- Icing potential:
    - -- Type according to four categories of algorithm for every 25 mb,
    - -- Remainder same as ETA MODEL,
- Ellrod index (same as ETA MODEL),
- Clouds and Weather (same as ETA MODEL),
- Relative humidity (same as ETA MODEL),
- Convective stability indices,
- Vorticity at 500 mb,
- Boundary layer winds, temperature, and dewpoint temperature,
- Low level convergence and upper level divergence,
- Vertical velocity,

- Upper level relative humidity,
- Mixing ratio,
- SELS package (see AVIATION MODEL),
- Precipitation (total, convective, stratiform).

LIMITED AREA FINE MESH (LFM) MODEL:

- Winds, heights, and temperatures at 850, 700, 500, and 250 mb levels,
- Vertical velocity at 1000, 850, 700, 500, 400, and 200 mb levels,
- Relative humidity at 850, 700, and 500 mb levels,
- Boundary layer relative humidity,
- Lifted index,
- Vorticity at 500 mb.

MEDIUM RANGE FORECAST (MRF) MODEL:

- 3-10 day forecast products not used for AIRMETs, SIGMETs, or area forecasts.

RAPID UPDATE CYCLE (RUC) MODEL:

- Winds (same as ETA MODEL),
- TKE:
    - Same as ETA MODEL,
    - Low levels (30, 60, 90, 120, and 150 mb levels above the ground),
- Ellrod index (same as ETA MODEL),
- Stability indices,
- Icing potential
    - Type according to four categories of algorithm for every 25 mb,
    - Remainder same as ETA MODEL,
- Clouds and Weather (same as ETA MODEL),
- Cloud bases and tops using icing algorithm,
- SELS package (see AVIATION MODEL),
- Convective stability indices,
- Vorticity at 500 mb,
- Boundary layer winds, temperature, and dewpoint temperature,
- Low level convergence and upper level divergence,
- Vertical velocity,
- Upper level relative humidity,
- Mixing ratio,
- Relative humidity every 50 mb from 1000 to 500 mb,
- Icing index (developmental)

RUC SURFACE PRODUCTS (products derived from surface analysis for RUC):

- Stability indices:
  - Lifted index,
  - Surface based Lifted Index,
  - Best Lifted Index,
  - Convective inhibition,
- Temperature
- Moisture convergence,
- Mean sea level pressure,
- Dewpoint temperature,
- Storm motion,
- Storm relative helicity,
- Relative humidity,
- Surface level of free convection,
- Storm tops.

MODEL OUTPUT STATISTICS (MOS) (probability forecasts):

- Clear Air Turbulence,
- Thunderstorms,
- Severe Thunderstorms,
- Temperature (maximum, minimum)
- Dewpoint Temperature,
- Precipitation Occurrence,
- Ceiling,
- Visibility,
- Sky Condition,
- Fog.

SYSTEM: Pencil and paper.

CONFIGURATION: Multiple pencils of various colors and lots of paper maps.

FUNCTIONS: Thinking tool for forecasters. Assimilate data.

INFORMATION PROVIDED: Maps of VOR locations (for determining AIRMET and SIGMET points),
Maps of various weather data (for example, for contouring IFR areas).

INFORMATION FORMAT: n/a

INFORMATION RETRIEVAL: n/a

INTERFACE TYPE: n/a

MODES OR ACTIONS: n/a

DATA TRANSMISSION FUNCTIONS: n/a

APPENDIX C

EVALUATION LOG SHEET

Date: ______________   FA: __________________

SCENARIO: ________________________ CURRENT WX ____

GOAL	ACTIVITY	DATA	SYSTEMS	OPTIONS	PROBLEMS

APPENDIX D

QUESTIONNAIRE RESULTS

AWC QUESTIONNAIRE RESULTS

Questions	Always	Sometimes	Never	N/A
1. Data entry prompts.	6	5	1	2
2. Function/hot key labels.	4	9	1	
3. Distinctive Alarms	13	1		
4. Alarms acknowledge and silence easily.	13	1		
5. Effective non-interfering alarms.	8	5	1	
6. Easy relearnable functions.	6	7	1	
7. Sufficient help.	3	8	2	1
8. Appropriate data entry devices.	8	6		
9. User-paced data entry.	9	2		3
10. Text inputs easily edited.	10	3		1
11. Minimal steps for data entry.	9	2		3
12. Quick positive feedback - data entry.	5	6	1	2

AWC QUESTIONNAIRE RESULTS (Continued)

Questions	**Always**	**Sometimes**	**Never**	**N/A**
13. Processing/ working message when delays	3	5	3	3
14. Error correction guidance.	4	5	2	3
15. Minimal mouse/keyboard shifting.	5	8	1	
16. Data easily followed over several pages.	9	3	1	1
17. Minimal memorization or interpretation.	3	8		3
18. Display updates keep pace with user/system.	7	7		
19. Text displays easily read.	10	4		
20. Consistent window control across displays.	9	4	1	
21. Wind overlays do not obscure important information.	7	7		
22. Easy to shift among several open windows.	12	2		
23. Data updates can be controlled by user.	5	4	2	2

AWC QUESTIONNAIRE RESULTS (Continued)

Questions	Always	Sometimes	Never	N/A
24. Easy to determine current mode among several options.	10	3		
25. Easy to activate desired menu option.	9	5		
26. Menu organized according to frequently used options.	9	5		
27. Easy to move among levels of menu hierarchy.	11	2		
28. Function keys consistent across operations.	4	1	8	1
29. Command language consistent across functions.	4	3	3	3
30. Command language easy to edit.	7	3	1	3
31. Procedures to prepare, send, receive, messages is consistent.	6	5	3	
32. Can interrupt/return to message preparation without data loss.	11	1		2

AWC QUESTIONNAIRE RESULTS (Continued)

Questions	Always	Sometimes	Never	N/A
33. Can defer message transmission until all messages are complete	11		1	2
34. Auto text format for standard products.	10	3		1
35. Status information of transmitted messages adequate.	8	4	2	
36. Data transmission procedures for messages compatible w/ data entry.	12	1		1
37. Frequently used displays are centrally located.	11	3		
38. Displays arranged by sequence of use or functional relations.	10	4		
39. All systems in reach of seated operator.	8	5		1
40. Monitors located horizontally comfortable.	9	4		1

AWC QUESTIONNAIRE RESULTS (Continued)

41. Viewing distance (seated) is comfortable.	11	2		1
42. Adjustable (enough) chairs.	11	3		
43. Workspace lighting minimize display glare.	2	8	3	1

QUESTIONNAIRE COMMENTS

QUESTION 1

The user is adequately prompted when data entry is required.

5 - Always   4- Sometimes   1- Never   2 - N/A

COMMENTS

You frequently just have to memorize what is needed.

VDUC soft tablet does not always prompt.

Both N-AWIPS ez scripts and VDUC use a common interface. One needs to know the command to get the workstation to respond.

We don't enter data into the computer.

VDUC: about 50% of the time, software prompts user.

Tablet function on VDUC sometimes disappears, making forecaster wonder if program has died or if it is still active.

QUESTION 2

Function keys and hot keys are adequately labeled.

3 - Always   8 - Sometimes   1 - Never   __ N/A

COMMENTS

VDUC menu screens require remembering which of the 10 possible numerals will get the correct screen.

Only the 486 terminal has labels for Word Perfect function key, everywhere else, including WP macros, you're on your own. Some are listed in various sources, but not on machines.

No labeled VDUC function keys (however we use them enough none are really needed).

Only word processor 486 has labels.

On VDUC some menus show hot key. Most hot key functions are not adequately labeled.

These labels are on screens which are activated by other unlabeled hot keys (VDUC and lightning displays are examples).

Function keys are not labeled.

VDUC system lacks proper identifications

VDUC: Function n keys are only labeled for WP; user must go to menu window to see labels for Function keys. N-AWIPS: no are labeled (system is mainly mouse-driven).

Function keys and their functions on HP machine (N-AWIPS) are unknown to forecasters. Function keys on VDUC have become familiar to forecasters and forecasters asked to no longer have them labeled.

QUESTION 3

Alarms are distinctive and easy to notice.

12 Always ___ Sometimes ___ Never ___ N/A

COMMENTS

Alarms are to easy to notice - the continual blinking is annoying, (i.e., PIREPS - N-AWIPS-are always coming in - perhaps only urgents should be alarmed - (thank goodness audible alarm was shortened on urgents), or have the regular PIREPS blink a couple of times and then stay solid white. If you see red - no alarms, white or blue, you know you have regular alarm or an urgent.)

Program errors on VDUC while highlighted in bold text, can often be unnoticed. On N-AWIPS, program errors are generally indicated by the program disappearing.

QUESTION 4

It is easy to acknowledge and turn off an alarm after its alerting purpose has been served.

11 Always 1 Sometimes ___ Never ___ N/A

COMMENTS

N-AWIPS - easy to turn off on a case by case basis as products come in but more difficult to adjust alarmed product list on a seasonal basis.

If you are busy composing your message, you can see the blinking light in your peripheral vision. This makes me nervous, especially if I don't have time at that exact moment to deactivate it. It's like water dripping in a faucet. It gets to you. We get so many alarms, you could spend a lot of time just hitting the button. Instead of continual flashing - have alarm turn color (to white) after a few blinks, that is enough of an alert.

QUESTION 5

Auditory alarms are effective in directing the user's attention to critical conditions, but do not interfere with other operations.

8 Always   3 Sometimes   1 Never   ___ N/A

COMMENTS

They are effective at attention getting, but piercing alarms quickly get on nerves.

N-AWIPS only when near unit with air conditioner off.

Auditory alarms always interfere with operations. They make one respond immediately if just to turn it off. Many times the response could wait a few minutes.

Only if it is NOT a continuous alarm.

Auditory alarms should be optional whether forecasters want on or off.

On VDUC, we have no way of knowing when the radar server crashes, since there is no alarm.

QUESTION 6

Functions that the user has not performed for a period of time are easily re-learned.

5 Always   6 Sometimes   1 Never   ___ N/A

COMMENTS

Depends on memory skills - varies quite a bit from person to person.

There is very limited documentation on seldom performed functions. The VDUC Help screens are the best aids we have. GEMPAC Help screens are also useful. Many times the Help screens are so confusing, you need a help screen to decipher the one you are looking at.

N-AWIPS: The problem is more one if you're gone for a period of time a number of things may have changed in the interim.

N-AWIPS & VDUC - No user cards or short instruction booklets with condensed instructions available. N-AWIPS - little usable documentation.

N-AWIPS GUI is easier than remembering command syntax on VDUC. AFOS command syntax is easier to remember than VDUC.

Changing "Wide Word" to "Tower" systems requires some relearning.

Lack of documentation on N-AWIPS system.

In the case of a program that has insufficient documentation that the user can refer to (e.g., gensig or igen on VDUC, nsat on N-AWIPS) (also - documentation for trouble shooting problems.

None of the systems have very good help facilities. The PC systems have a help facility and most programs have help, but in general, help is very lacking.

QUESTION 7

Sufficient help (on-line, manuals) exists for functions not easily relearned.

2 Always   8 Sometimes   1 Never   1 N/A

COMMENTS

Documentation is minimal on all systems.

N-AWIPS has very little help.

Things are changing so frequently, its hard to keep up (N-AWIPS). Sometimes documentation lags behind changes, however, most things are documented reasonably well.

All systems lack sufficient documentation.

VDUC - documentation not user friendly, no handy condensed booklets. N-AWIPS - little documentation.

AFOS - none; VDUC - fairly good with helps; N-AWIPS - Not very good.

Usually I just ask colleagues.

N-AWIPS

In the case of a program that has insufficient documentation that the user can refer to (e.g., gensig or igen on VDUC, nsat on N-AWIPS) (also - documentation for trouble shooting problems.

None of the systems have very good help facilities. The PC systems have a help facility and most programs have help, but in general, help is very lacking. (same problem as #6)

QUESTION 8

Input devices (e.g., keyboard, cursor, mouse, or joystick) are appropriate for the tasks being performed.

7 Always 5 Sometimes ___ Never ___ N/A

COMMENTS

VDUC - using the mouse to precisely locate a point is sometimes frustrating, however, I think that's due to software design.

I have 4 keyboards and 3 mice in front of me. This is so many items that some must be set back or spaced so far apart that reaching them is difficult.

We have so many different keyboard/mice that it can get a little confusing at times. In general, however, the input devices are appropriate for the tasks (would however like to move the clear button ANWX screen, for example, to a more central location--- like on the map top - since it is often used.)

Keyboards with built in cursors would be more convenient for 2nd N-AWIPS

N-AWIPS - good; VDUC - mouse activation very sluggish; AFOS - good

Need consolidation of keyboards/mice. There is some confusion about which mouse/keyboard to use.

QUESTION 9

Data entry is user-paced, rather than system-paced.

8 Always 1 Sometimes ___ Never 3 N/A

COMMENTS

VDUC IGEN program very slow to response. N-AWIPS sometimes slow to respond.

Sometimes system is slow in responding to user which makes user uncertain if action has been accepted by the system.

QUESTION 10

Text inputs are easy to edit.

9 Always 2 Sometimes ___ Never 1 N/A

COMMENTS

Lack of examples & instructions for N-AWIPS & VDUC.

Except for AFOS; best text input: VDUC which allows one to call up previous entry to make a minor change rather than re-type entire entry.

Text editing on VDUC for SIGMET generation difficult if not impossible.

QUESTION 11

Data entry requires a minimal number of steps.

7 Always　　2 Sometimes　　___ Never　　3 N/A

COMMENTS

(N-AWIPS) GEMPAK stuff can get a little drawn out.

N-AWIPS - requires mouse to move to text entry point in window, then keyboard entry.

QUESTION 12

The system provides quick, positive feedback on the acceptance or rejection of data entry.

5 Always　　4 Sometimes　　1 Never　　2 N/A

COMMENTS

AFOS emulator on N-AWIPS does not give much of a clue what you may have done wrong when entering AFOS text. e.g., you need to know to enter MKCFD2FA3. If you put in just FD2FA3 like on AFOS, it says its not in data base. Real problem is you didn't ask the question the way it was expecting it (the way we did on AFOS). Why do we have to proceed things with "MKC"? why isn't MKC the default as with AFOS?

VDUC - Feedback frequently delayed on text commands.

None of the systems are great on this.

VDUC - response sometimes slow.

Depends on workload of processor.

Mostly never on most programs on the system. Entering commands on VDUC mainframe is main culprit.

Sometimes, use radar center [procedures?] are not accepted on VDUC.

QUESTION 13

Where the system requires substantial time to process a data entry, there is an adequate "PROCESSING" or "WORKING" message.

2 Always 5 Sometimes 2 Never 3 N/A

COMMENTS

VDUC - Some jobs go into a queue for processing that must be viewed on command of user.

The systems don't tell us this.

Rarely a problem but on occasions where it does happen there do not seem to be any messages.

VDUC - Backlog of jobs frequent. N-AWIPS - few messages.

VDUC has a few of these. The other systems have none.

No system has this feature.

VDUC - One must query the machine for a status indication, don't know enough about N-AWIPS yet to venture an opinion.

All systems give little/no feedback when working on long tasks.

QUESTION 14

When a data entry error is detected, the system provides adequate guidance on how to correct the error.

4 Always 3 Sometimes 2 Never 3 N/A

COMMENTS

VDUC/N-AWIPS/AFOS - Error messages are cryptic - seems like system might suggest proper spelling or command (like a spell checker) or suggested syntax.

Not aware of any guidance of this type.

VDUC & N-AWIPS

AFOS has some of these. N-AWIPS & VDUC do not.

Error message may be too cryptic or too vague to let user know what the actual problem is.

An effort has been made on the PC's to provide this, but is lacking on the other systems.

When moving center [unreadable FA 13].

QUESTION 15

The system minimizes shifting from mouse to keyboard inputs.

5 Always 6 Sometimes 1 Never ___ N/A

COMMENTS

N-AWIPS - always going from mouse to keyboard, the checking to see if right window is active.

N-AWIPS seems to require a lot of jumping back and forth between mouse and keyboard.

We do a fair amount of switching between the two.

N-AWIPS - AFOS products not in menu. VDUC - IGEN program.

Word processing is probably the worst offender.

This is always a problem. Input needs to be one or the other.

N-AWIPS: Yes, except for GEMPAK & EZSCRIPTS; VDUC: No; mouse & keyboard inputs are about 50-50 depending upon the task.

This is mostly the case on the systems. If it is done (shifting) it is probably because it was unavoidable to do it any other way.

The creation of convective SIGMETs requires input from both mouse and keyboard.

QUESTION 16

It is easy to follow data that are displayed over multiple pages.

7 Always 3 Sometimes 1 Never 1 N/A

COMMENTS

VDUC limited scroll (80? rows).

Scrolling is the only method.

Only if page has scroll capability

QUESTION 17

Data displays minimize the requirement for memorization or interpretation.

3 Always 6 Sometimes ___ Never 3 N/A

COMMENTS

Or maybe we're just used to it.

Color coded displays on N-AWIPS for showing layers with index to the side are hard to interpret. Contours with label are much better.

N-AWIPS - AFOS product labels overwritten or moved off screen when zooming.

Some VDUC & N-AWIPS displays require memorization or interpretation.

VDUC needs graphics looping.

Too many colors sometimes. You must look to the bar graph on the side of display for reference.

However, one must know a priori the format of the command.

Displays are labeled, however, zooming causes labels to be lost which can often be problem if the forecaster gets distracted by another problem.

Meteorological data requires interpretation.

QUESTION 18

18. Display update rate is fast enough to keep pace with user and system actions.

6 Always 6 Sometimes ___ Never ___ N/A

COMMENTS

AFOS - Graphical update too slow.

VDUC is generally too slow.

VDUC is slow.

When any system is under heavy load, it is slower.

Sat updates can take 3-4 minutes sometimes.

VDUC is better at this than N-AWIPS due to VDUC keeping loops in constant memory.

QUESTION 19

Text displays are easy to read.

9 Always 3 Sometimes ___ Never ___ N/A

COMMENTS

N-AWIPS some text is quite small.

A lot of text is too small to easily read.

VDUC monitors are old - making it difficult to read overlaid text (on satellite data, etc.)

Text is often made too small and needs to be enlarged for better visibility.

QUESTION 20

The method for controlling windows is consistent across displays.

9 Always 3 Sometimes ___ Never ___ N/A

COMMENTS

N-AWIPS - button 2 used for zooming NWX map, button 1 for other displays.

Existing programs on N-AWIPS is inconsistent.

Depends - since we currently use 5 different systems w/5 different methods, it certainly is not consistent.

Every system is different though windowing on HP and PCs have similarities.

Zoom features differ between VDUC and N-AWIPS.

QUESTION 21

Window overlays are situated so that they do not obscure important information.

5 Always 7 Sometimes ___ Never ___ N/A

COMMENTS

The window overlay can be moved so this is not much of a problem, but I wish N-AWIPS had a better way to display menus. Most of the time, I use the black data input bar on the AFOS emulator. I don't need the big menu overlay most of the time.

Only to the extent that you are free to move the windows around.

N-AWIPS - windows need to be manually resized/repositioned each time window is reinitialized.

Need at least 3 N-AWIPS displays at each desk to avoid the problem.

Windows overlap in N-AWIPS.

One will have to set-up N-AWIPS to do that. The others don't have that.

They are flexible and can be made so.

QUESTION 22

Where several windows are displayed simultaneously, it is easy for the user to shift among them to select which window is to be made active.

11 Always 1 Sometimes ___ Never ___ N/A

COMMENTS

N-AWIPS - may pile up on top of one another; difficult to tell how many are active.

N-AWIPS can be annoying in this regard as window clicked in will not pop to front. This needs to be configurable for forecaster performance.

QUESTION 23

Data updates can be controlled by the user.

4 Always (missing 1) 3 Sometimes 2 Never 2 N/A

COMMENTS

They are automatically updated.

N-AWIPS later data not available with a simple key stroke. Must reenter product display menus.

Some control on N-AWIPS only.

Set automatically.

Only for internally-generated products; data flowing in from outside sources is dependent on comms and other outside forces.

Data loads automatically most of time. .....[unreadable # 13]

QUESTION 24

Where there are several possible modes of operation (e.g., EDIT, MONITOR), the user knows what mode he is currently in.

10 Always (missing 1)   1 Sometimes   ___ Never   ___ N/A

COMMENTS

(not always) e.g., on N-AWIPS, one may have several versions of the same program running w/o knowing it because messages from computer do not clearly indicate it.

IGEN on VDUC is biggest culprit as sometime the edit screen will mysteriously disappear.

On VDUC, sometimes it is difficult to tell if you are off or on the host system.

QUESTION 25

It is easy to activate the desired menu option.

7 Always   5 Sometimes   ___ Never   ___ N/A

COMMENTS

VDUC sometimes mouse/cursor seems to get out of synch with menu system as when redefining a loop.

(If you know where to look).

VDUC & N-AWIPS- mice sometimes hard to position.

VDUC is very inconsistent about a response.

VDUC mouse is awful.

If you can recall which keys to hit.

QUESTION 26

The menu hierarchy is organized so that critical or frequently used options are easy to select.

8 Always 4 Sometimes ___ Never ___ N/A

COMMENTS

N-AWIPS menus seem to be in any order.

N-AWIPS - menus not organized according to frequency of use.

NSAT in N-AWIPS can be tedious to start.

There is pretty much no hierarchy.

Menus on all systems need to be re-thought to minimize actions that forecaster must go through to get the data. With more and more models, data, etc., this is a big challenge.

QUESTION 27

It is easy to move among different levels of the menu hierarchy.

9 Always 2 Sometimes ___ Never ___ N/A
(missing (1)

COMMENTS

N-AWIPS - requires excessive mouse involvement. Menus not adjacent.

VDUC is unpredictable in this regard.

VDUC mouse menu is awful.

VDUC more logical than N-AWIPS because VDUC has more coherent menu structure.

QUESTION 28

The assignment of functions to function keys is consistent across different operations.

3 Always 1 Sometimes 7 Never 1 N/A.

COMMENTS

Function keys on Word Perfect in 486 quite different from function keys on VDUC - but it has not presented a problem.

Each system does its own thing. Sometimes they change from workspace to workspace. It's hard enough to go to convective SIGMET to fill-in without trying to remember all the different aspects of the hardware/software.

Function keys are different on each system.

Systems have different function keys which perform (or don't perform) different functions.

Function keys have totally different meanings on each system.

Each system has its own function key assignment.

This is something that was well-done with function key structure on VDUC.

Function keys on VDUC have different ....[unreadable]

QUESTION 29

Wording of command language is consistent across different functions.

3 Always 2 Sometimes 3 Never 3 N/A
(Missing 1)

COMMENTS

It changes from main frame to host.

CLI (Data terminal (?)), OS2 (PC), UNIX (N-AWIPS).

What do you mean by Command Language?

N-AWIPS - UNIX, 486 & VDUC - DOS & OS/2.

Every system is different.

Command languages differ between VDUC, N-AWIPS, ...? #13

QUESTION 30

Command language is easy to edit.

7 Always 1 Sometimes 1 Never 3 N/A

COMMENTS

N-AWIPS - I know it's possible, but have not got into text.

What do the Forecasters edit except their products.

N-AWIPS - Control language use kept secret and confidential.

Command line editing is fairly easy on all the systems, but in reality forecasters are not familiar with how to do it.

Command language difficult to edit on N-AWIPS.

QUESTION 31

Procedures for preparing, sending and receiving messages are consistent across systems.

6 Always 3 Sometimes 3 Never ___ N/A

COMMENTS

Each system does its own thing. AFOS has different key ins than VDUC while N-AWIPS uses the menu & mouse.

Difference between convective SIGMETs, int'l SIGMETs & the AIRMETs/FAs. Each of the 3 is done differently.

N-AWIPS - does not use AFOS standards to display national and local products - Requires 9 letter products.

Each has its own interface.

It depends on the message.

Not with 5 different systems using 5 different sets of input commands.

Preparation done on PC platform unless it's an emergency. So in 99% of the cases procedures are consistent.

Differing transmission procedures for convective SIGMETs and International SIGMETs.

QUESTION 32

Users can interrupt and return to message preparation tasks without data loss.

10 Always ___ Sometimes ___ Never 2 N/A

COMMENTS

This is because we have a stand alone - dedicated word processor.

The 486 is separate from N-AWIPS, AFOS, & VDUC.

True on PC, but not on VDUC.

QUESTION 33

If user is sending a batch of messages, the user can defer transmission until all messages are complete.

9 Always ___ Sometimes 1 Never 2 N/A

COMMENTS

We can't do this. Is it desirable?

QUESTION 34

Text is automatically formatted for standard products (e.g., AIRMETs).

8 Always 3 Sometimes ___ Never 1 N/A (didn't know meaning)

COMMENTS

Only in the case of Int'l SIGMETs; for all other products, only the points are formatted (on VDUC) while the text is partially preformatted on a different PC using Word Perfect.

Never on SIGMETs/AIRMETs/AREA forecasts. Mostly on International SIGMETs; Some on convective SIGMETS.

Not all formats are available.

The text of even standard products varies to the point that it is automated as much as possible.

QUESTION 35

The user is provided adequate status information on transmitted messages.

7 Always 3 Sometimes 2 Never ___ N/A

COMMENTS

There is currently no provision to let us know if the switch has received our products through Gateway.

Sometimes they get lost at Gateway and our first clue is the field calling wanting to know where the message is.

We are never "sure" that our products have made it to Atlanta.

Things can be hung up/not go out, & you really don't know what the problem is (i.e., no message given) (unless you are a communications expert.)

Status of Gateway - Rehost - not available.

486s in aviation do not provide acknowledgments when products are sent to AFOS.

VDUC to 486 word processor: there is no checking done to verify the `from line' was correctly received by the 486. 486/mv transmission of AWC products does not give us suitable verification that the wmsc has received the message--- this is because we no longer transmit directly to WMSC ---but we need reliable quick verification

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QUESTION 36

Data transmission procedures for composing messages are compatible with general data entry procedures (e.g., such as word processing procedures).

10 Always ___ Sometimes 1 Never 1 N/A

COMMENTS

Not sure I understand the question, but----message transmission procedures are a completely separate entity from product-building and data analysis pcdrs.

What does transmission have to do with composing?

Different version of OSL on VDUC vs 486; UNIX running on N-AWIPS makes error/trouble diagnosis difficult. WSI generation on VDUC requires a space in the format `6s L 3 E' Whereas the file name in the 486 has no space `3E'.

QUESTION 37

Most frequently used displays are located centrally for easy viewing.

9 Always 3 Sometimes ___ Never ___ N/A

COMMENTS

Important monitors like lightning display and NATRADAR are over your shoulder.

As much as space allows.

We have so many frequently used displays - not possible for them to all be "centrally" located.

Radar display not "centrally" located.

QUESTION 38

Displays are arranged according to their sequence of use or functional relations.

9 Always 3 Sometimes ___ Never ___ N/A

COMMENTS

Switching back and forth is common.

Different people use different systems. N-AWIPS is inconvenient to type on in both the East and West work areas.

Radar and lightning displays not adjacent.

VDUC display a little far away for easy access when working at PC on products.

QUESTION 39

All systems/monitors/keyboards are within reach of the seated operator.

7 Always 4 Sometimes ___ Never 1 N/A

COMMENTS

Some relocation of chair position is required -- 5 keyboards are arranged in an arc w/ approx. 5 ft from end to end.

N-AWIPS hard to type on.

Have to move around. Good thing chair is on wheels.

N-AWIPS keyboards may require stretching to reach.

Too many keyboards and mice in close proximity causing confusion.

VDUC display a little far away for easy access when working at PC on products. (same as 38)

CPUs for WSI server and VDUC station are in another room - monitor for WSI server is in another room which makes it difficult to monitor the status of the WSI server.

QUESTION 40

Monitors are located at an appropriate height so that the user can comfortably view monitors (i.e., users don't have to look up or look down excessively).

8 Always 3 Sometimes ___ Never 1 N/A

COMMENTS

Some weather displays are out of direct sight.

Some (VDUC, N-AWIPS/ Lightning monitors are too high.

Many displays rather low.

Lightning and radar monitors are not in optimum position. Require head swivel and tilts.

QUESTION 41

The viewing distance from the display to the seated operator is comfortable.

9 Always 2 Sometimes ___ Never 1 N/A

COMMENTS

Proper range is difficult for bifocal users.

Radar display remote

QUESTION 42

Chairs are adjustable to ensure users' can comfortably access the work space (i.e., keyboards, mice, work table).

9 Always 3 Sometimes ___ Never ___ N/A

COMMENTS

Very comfortable, but more height adjustment needs to be available.

Arms on chairs sometimes interfere.

QUESTION 43

Work space lighting minimizes display glare.

2 Always 6 Sometimes 3 Never 1 N/A

COMMENTS

Once you close the blinds.

Overhead fluorescent lights - some have diffusers, others don't; location of windows adds additional glare; Venetian blinds help some; would like to see "shade" apparatus above screens.

Window and overhead light glare is a significant problem on all systems.

Glare can be a problem in all sections.

Glare from open windows and lighting is a definite problem.

Windows glare during daylight if blinds not closed; glare from ceiling lights visible at all times.

Some glare in central FA from window light.

Windows are near workstations.

Blinds have to be drawn at times to reduce glare.

Glare a problem at Central workstation due to location of windows (and natural lighting).

Can sometimes get glare from window.

GENERAL COMMENTS

QUESTION 1

Please explain any additional system interface problems (i.e., menu structure, help system, data presentation) not addressed in the previous questions.

COMMENTS

Piecemeal training has been a problem in the past when a new system is introduced - a tutorial would be helpful.

Network problems between computer system can be difficult to isolate.

Help systems - missing or inadequate information provided - VDUC & N-AWIPS. Unable to simultaneously & continuously display many maps - etc. When typing without leaving keyboard to move mice, use other keyboards, etc.

Mouse signal is not accepted by VDUC when system is busy making mouse commands very tedious.

Need more documentation on N-AWIPS. Call back personnel for N-AWIPS emergencies also need to be determined.

QUESTION 2

Please explain any additional work space layout problems (i.e., desk height, display location, chair characteristics) not addressed in the previous questions.

COMMENTS

Too many "mice" on your desk (which one is for which monitor)?

Central FA does not have enough space to lay items that are needed for composition at FA.

While we are well into the video age, a good meteorologist still likes to analyze maps so layout must allow sufficient flat work space for map analysis; ability to make hard copies is also a must.

Current arrangement near limit of desired horizontal extent. Some keyboards are too high, the one for word perfect is about right.

There are 10 monitors (screens & 4 keyboards in front of me. I wonder if there is any way to condense this into a functional & usable work space.

Lack of hard copy devices near worksite. Work space too congested with keyboards & mice; need more stacked displays.

Computer tables are a joke. Keyboards mostly too high and crammed together.

Many keyboard/mouse locations are too high on the workstation.

Need heavy duty chairs which hold up to rigors of 24 hour use. Cylinders on adjustable chairs often prematurely wear out.

Map boards are difficult to reach.

QUESTION 3

Please feel free to provide any additional comments regarding your displays/systems and physical work environment.

COMMENTS

For any workstation, designer should keep in mind that a single monitor (e.g., to display satellite imagery, radar, and/or forecast data) is not sufficient - systems must have <u>at least 2</u> display monitors.

Too many keyboards and mice. Trackballs incorporated with keyboards would help. A single keyboard switchable to different systems would help. Need to be able to view a larger number of updated products when composing, without continuously having to change keyboards and move mice, etc.
